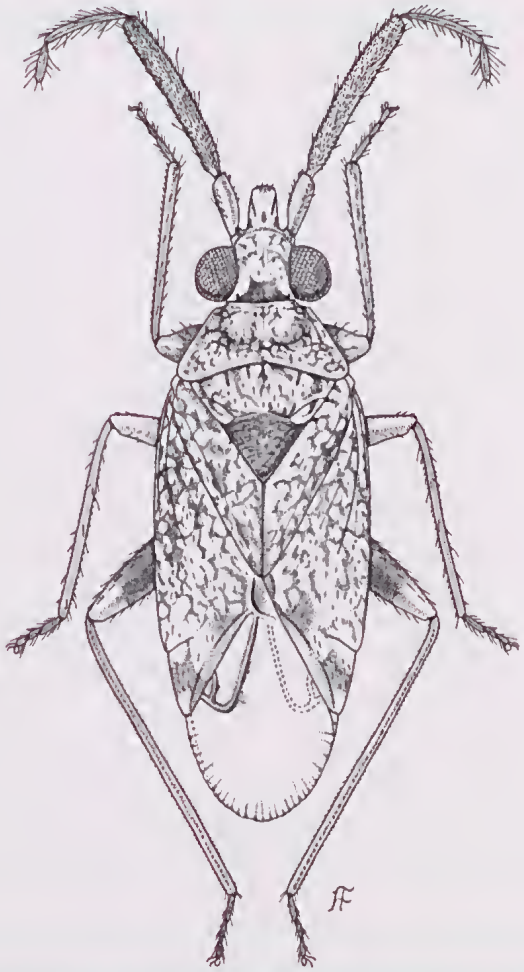
MEMOIRS

OF THE

QUEENSLAND MUSEUM



BRISBANE
11 NOVEMBER 2006

VOLUME 52
PART 1

VOLUME 52
PART 1

MEMOIRS

OF THE

QUEENSLAND MUSEUM

Minister: Hon. R. Welford, MLA
Director: I.D. Galloway, PhD
Editor in Chief: J.B.N. Hooper, PhD
Subject Editors: C.J. Burwell, PhD; P.J.F. Davies, PhD
Managing Editor: S.M. Verschoore, BA

PUBLISHED BY ORDER OF THE BOARD

11 NOVEMBER 2006

© Queensland Museum
PO Box 3300, South Brisbane 4101, Australia
Phone 61 3840 7555
Fax 61 7 3846 1226

National Library of Australia card number
ISSN 0079-8835

NOTE

Papers published in this volume and in all previous volumes of the Memoirs of the Queensland Museum may be reproduced for scientific research, individual study or other educational purposes. Properly acknowledged quotations may be made but queries regarding the republication of any papers should be addressed to the director. Copies of the journal can be purchased from the Queensland Museum Shop.

A Guide to Authors is displayed at the Queensland Museum web site www.qm.qld.gov.au/organisation/publications/memoirs/guidetoauthors.pdf

A Queensland Government Project
Typeset at the Queensland Museum
Printed by Watson Ferguson & Company
1/655 Toohey Road, Salisbury, Queensland 4107

A PECULIAR NEW GENUS OF ARBORICOLOUS LEBIINAE FROM INLAND AUSTRALIA (INSECTA: COLEOPTERA: CARABIDAE)

MARTIN BAEHR

Baehr, M. 2006 11 10: A peculiar new genus of arboricolous Lebiinae from inland Australia (Insecta: Coleoptera: Carabidae). *Memoirs of the Queensland Museum* 52(1):1-6. Brisbane. ISSN 0079-8835.

A new genus and species of arboricolous lebiine ground beetles, *Brigalowia setifera*, gen. et sp. nov., is described from central and northwestern Queensland and adjacent parts of the Northern Territory. This tiny and very peculiar species is tentatively placed in the tribe Dromiini, but is outstanding, *inter alia*, for its remarkably wide, depressed body and the extreme length of all tactile setae. These structural modifications are probably due to its preferred microhabitat within deep cracks in the bark of rough-barked acacias in arid and semi-arid inland Australia. ❐ *Coleoptera, Carabidae, Lebiinae, Australia, new genus, new species.*

Martin Baehr, Zoologische Staatssammlung, Münchhausenstr. 21, D-81247 München, Germany. (e-mail: martin.baehr@zsm.mwn.de); *1 July 2006.*

Recently, Dr Geoff Monteith of the Queensland Museum, Brisbane, sent me a photo of a bizarre, small carabid beetle that he had captured while pyrethrum fogging the rough bark of acacia trees (*Acacia harpophylla* F. Muell. ex Benth., *A. cambagei* R.T. Baker) in semi-arid inland Queensland. My first impression of the photo was that these beetles might represent a very unusual species of the carabid subfamily Perigoninae. However, after receiving the small sample of specimens I recognised that they belonged to the subfamily Lebiinae, and most probably to the tribe Dromiini, although in shape and structure they are outstanding within the tribe and do not resemble any other dromiine beetles known to me.

These beetles are part of a still largely unknown invertebrate community living in the deep cracks of the rough bark of acacias and diverse eucalypts in Australia, that can only be sampled by fogging the bark. This method, however, has been mainly employed in rainforest where it has been used with great success, especially by staff of Queensland Museum (for method see Baehr, 1995), and much less commonly in open forest and woodlands. However, from my own experience it can yield surprisingly numerous and diverse results even in semi-arid and arid country (e.g. Baehr, 2002). The present paper should serve to stimulate collectors to use this method more widely, even in semi-desert areas throughout Australia. Such sampling will bring to light many outstanding new species, not only within Carabidae, but probably in many other insect and non-insect invertebrate groups.

MATERIAL AND METHODS

A small sample of 7 specimens was captured during 2000–2003 at several localities in central and northwestern Queensland and adjacent eastern Northern Territory. All specimens were fogged from the bark of brigalow (*Acacia harpophylla*) and gidgee (*A. cambagei*) using aerosol pyrethrum.

The male genitalia and female stylomeres were removed from specimens, softened for a night in a jar in moist atmosphere, then cleaned for a short while in hot KOH.

ABBREVIATIONS. QM, Queensland Museum, Brisbane; CBM, Collection M. Baehr, Munich.

Measurements were taken using a stereomicroscope with an ocular micrometer. Body length was measured from the apex of labrum to the apex of elytra. Length of the pronotum was measured along its midline. Length of the elytra was taken from the most advanced part of humerus to the most advanced part of apex.

Brigalowia gen. nov.

TYPE SPECIES. *Brigalowia setifera* sp. nov.

DIAGNOSIS. Genus of subfamily Lebiinae and within this, most probably of the tribe Dromiini. Characterised by the following: body shape extremely wide, depressed; all tactile setae on body extremely elongate; labrum short and wide, 6-setose; mentum tooth present; glossa elongate, bisetose apically; paraglossae hyaline, united with glossa; lacinia sparsely setose; palpi acute,

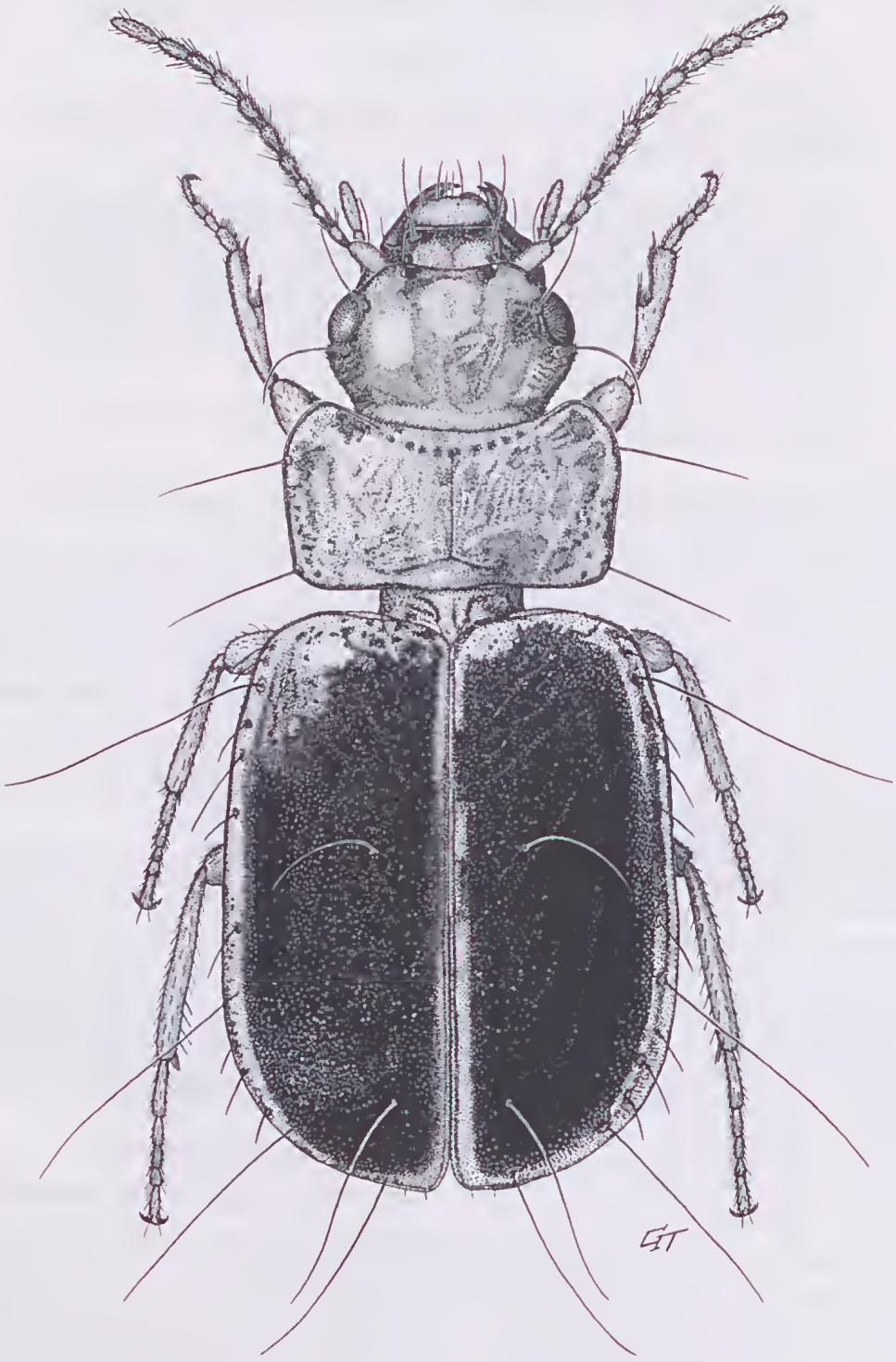


FIG. 1. *Brigalowia setifera* gen. et sp. nov.; habitus, body length 3.4mm.

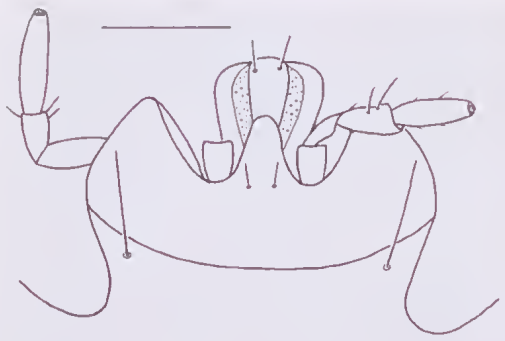


FIG. 2. *Brigalowia setifera* gen. et sp. nov.; mouthparts, ventral view showing mentum, left maxillary palp and right labial palp, scale: 0.25mm.

not widened at apex; noteh near apex of male mesotibia absent; tarsi denticulate; aedeagus short, with the orifice on left side; internal sac with a coiled, sclerotised plate; 2nd female stylomere straight and elongate, devoid of ensiform setae but covered at tip by a fringe of a few minute hairs.

ETYMOLOGY. The generic name is feminine and refers to its occurrence on brigalow acacias (*Acacia harpophylla).*

DISTRIBUTION. Central and northwestern Queensland, and adjacent eastern Northern Territory.

RELATIONSHIPS. The tribal placement of *Brigalowia* is problematic. The form of the female stylomere 2, which is elongate, finely pilose apically and lacks any lateral ensiform setae, and the shape and setosity of the glossa and paraglossae are most similar to those of *Anomotarus* and its allies in the tribe Anomotarini. However, the short, wide labrum, the narrow, un-widened palpi, and the shape and structure of the aedeagus indicate dromiine relations. Because there are no similar genera known at present, the problem cannot be resolved now. If *Brigalowia* does indeed belong in Dromiini, then it is outstanding within this tribe and is certainly without close relatives.

Brigalowia setifera sp. nov.
(Figs 1–4)

MATERIAL. HOLOTYPE: ♂, QLD: 23°32'S × 145°02'E, Barcaldine, 27km W., 9 Jul 2003, GB Monteith. pyreth./gidgee. [11359] (QMT 123607). PARATYPES: 1 ♂, same data (CBM); 2 ♀♀, QLD: 20°59'S, 140°55'E, Scrubby Ck., SE of Cloncurry, 8 Jul 2003. G. Monteith. pyreth./gidgee. [11349] (CBM, QM); 1 ♀, QLD: 24°49'S, 149°45'E, Brigalow

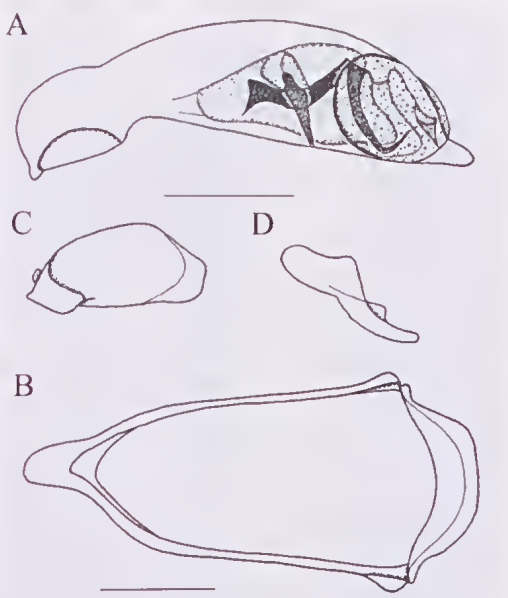


FIG. 3. *Brigalowia setifera* gen. et sp. nov.; male genitalia; A, aedeagus; B, genital ring; C, left paramere; D, right paramere, scale: 0.25mm.

Res. Stn. site 2, 13 Oct 2001, G. Monteith, C. Burwell, 170m, Pyrethrum, brigalow trunks. [10222] (QM); 1 ♂, SEQ: 24°48'S, 149°45'E, Brigalow Res. Stn. site 5, 16 Dec 2000. G. Monteith, vinescrub, 160 m. pyrethr.-trunks & logs. [9863] (QM); 1 ♀, NT: 19°56'S, 137°19'E, Barkly Hwy, 6-Mile Ck. 7 Jul 2003. G. Monteith. pyrethr./gidgee. [11347] (QM). (Numbers within square brackets are Queensland Museum sample codes).

DIAGNOSIS. As for genus.

DESCRIPTION. *Measurements.* Length: 3.20-3.55mm; width: 1.45–1.65mm. Ratios. Width/length of pronotum: 2.15–2.25; width base/apex of pronotum: 1.28–1.35; width of pronotum/width of head: 1.30–1.34; length/width of elytra: 1.24–1.32; width of elytra/width of pronotum: 1.27–1.35.

Colour. Head, pronotum, humerus and narrow lateral margin of elytra light reddish, disc of elytra more-or-less light brown; mouthparts and antennae reddish; lower surface reddish, except for much of thorax which is light brown; legs yellow.

Head. (Figs 1, 2) Large, short and wide, laterally strongly rounded. Eye small, gently convex, as long as distance from orbit to neck sulcus. Orbit very oblique, laterally slightly protruding over eye, anteriorly convex and incurved towards

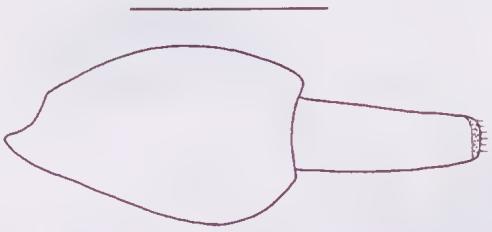


FIG. 4. *Brigalowia setifera* gen. et sp. nov.; female stylomeres, scale: 0.1mm.

eye. Therefore, neck considerably narrower than widest part of head, though still very wide. No distinct frontal sulci perceptible. Labrum short, wider than long, 6-setose, setae not unusually elongate. Mandibles rather short, with acute, strongly incurved apex. Mentum with elongate, anteriorly convex but not triangular tooth, with 2 minute setae behind tooth. Submentum laterally with a single seta on each side. Both pairs of palpi narrow, elongate, narrowed towards apices. Preapical palpomere of labial palpus bisetose, apical palpomere sparsely pilose. Maxillary palpus impilose, except for some terminal setae on preapical palpomere. Antenna rather short, barely surpassing base of pronotum, median antennomeres little longer than wide, antenna pilose from middle of 4th antennomere. Clypeal, supraorbital, and submental setae and seta on basal antennomere, extremely elongate. Posterior supraorbital seta situated behind eye. Surface of head without microreticulation, very glossy, with extremely fine, sparse punctation, impilose, but orbits laterally with very short, sparse pubescence.

Pronotum. (Fig. 1) Very wide and short, much wider than head, surface depressed. Apex very deeply excised, apical angles strongly protruding, almost enclosing basal part of head, though broadly rounded at tips. Lateral margins anteriorly convex, gently concave in basal two-thirds. Basal angles rectangular though rounded at tips. Base very gently bisinuate, laterally produced towards basal angles. Median line inconspicuous, apical and basal transverse furrows barely indicated. Marginal channel wide throughout, evenly widened towards apex, explanate. Apex not margined, base narrowly margined. Both pairs of marginal setae extremely thick and elongate, anterior setae situated at widest diameter at anterior third, posterior setae situated precisely on basal angle. Pronotal surface without microreticulation, highly glossy, with extremely fine and sparse punctation, impilose, though margins with sparse fringe of extremely short, fine hairs that run around apical and basal angles.

Elytra. (Fig. 1) Short and very wide, markedly rectangular, surface depressed. Humerus rounded, basal margin almost transverse, narrowly margined to scutellum. Lateral margins almost parallel, apex obliquely rounded, not sinuate. Striae absent, though position of inner striae, under high magnification, indicated by extremely fine, barely recognisable rows of minute punctures. Elytral surface without microreticulation, highly glossy, with extremely fine and sparse punctation, impilose, though margin at humerus with sparse fringe of extremely short and fine setae that extends around base. Disc with two remarkably elongate setae situated at position of 3rd interval slightly in front of mid-length and near apex; anterior seta apparently situated near 3rd stria, the posterior one near 2nd stria. Lateral margin with 5 anterior, 1 intercalar and 5–6 posterior marginal setae, and with one additional apical seta located close to suture. All setae extremely elongate. Hindwings fully developed.

Lower Surface. Metepisternum elongate, c. 2x as long as wide. Abdominal sterna with sparse, very short pilosity, each sternum bisetose in middle. Terminal abdominal sternum in ♂ bisetose, in ♀ quadrisetose. Terminal setae extremely elongate, other setae shorter though still unusually elongate.

Legs. Rather narrow and elongate. Femora sparsely pilose. Tarsi impilose on upper surface; claws pectinate, with 3–4 small teeth. 2nd - 4th tarsomeres of ♂ protarsus with asymmetrical vestiture of adhesive hairs.

Male Genitalia. (Fig. 3) Large compared to body size. Genital ring (Fig. 3B) narrow, elongate, slightly triangular, barely asymmetric, with elongate apex. Aedeagus (Fig. 3A) slightly asymmetric, short and stout, not depressed, orifice short, situated on left side; lower surface gently convex, apex short, stout, situated on right side. Internal sac with rather complex folding, in middle with a spirally-coiled, heavily-sclerotised plate that is apically produced into a less-sclerotised rod. Parameres very dissimilar, asetose; left (Fig. 3C) large, wide, markedly triangular, right (Fig. 3D) small, elongate.

Female Genitalia. (Fig. 4) Stylomeres elongate, 1st stylomere without setae at apex, 2nd stylomere narrow, elongate, straight, without ensiform

FIG. 5. Gidgee trees (*Acacia cambagei* R.T. Baker); A, tree habit; B, detail of bark. (Photos: G.B. Monteith)

setae, but with fringe of 4-6 extremely minute hairs at apex.

Variation. Apart from minor differences in relative shape of pronotum and elytra, very little variation noted.

DISTRIBUTION. Central and western Queensland, adjacent eastern Northern Territory.

COLLECTING CIRCUMSTANCES. All specimens were sampled by pyrethrum fogging the bark of rough-barked acacias, namely brigalow (*Acacia harpophylla*) and gidgee (*A. cambagei*). Nothing else is recorded about the habits and life history.

ETYMOLOGY. The species name refers to the extreme length of all tactile setae.

REMARKS

The wide, remarkably depressed body shape and the extremely elongate, tactile setae on the pronotum and elytra render these tiny beetles outstanding within the Australian lebiine carabid beetles. The Australian carabid fauna is particularly rich in such tree living and mainly corticolous or subcorticolous species that live either under loose bark on the trunks of a number of eucalypt trees, or within deep cracks in the bark of a variety of trees of various families (eucalypts, acacias and others) that possess a thick, rough bark structure (Baehr, 1992, 1997, 2002, 2005). It has been estimated that in Australia more than a quarter of the whole carabid fauna may be adapted to such a bark-inhabiting lifestyle (Baehr, 2004).

The thick bark of acacias like brigalow and gidgee is composed of a thick layer of multiple dead flakes 5–8cm deep (Fig. 5) and provides numerous, very narrow spaces for a multitude of subcorticolous animals of various groups. A distinctive flattened spider, *Platylampona mazeppa* Platnick (Lamponidae), has recently been described from this situation (Platnick, 2004). Other flattened taxa from the same habitat, yet to be described, include a new subfamily taxon of pentatomid Hemiptera and a new genus of large coccinellid beetles (G. Monteith, pers. com.), as well as a another new genus of markedly depressed lebiine

carabids related to the genus *Anomotarus*, under study by the author. *Brigalowia* is clearly another element of this unusual Australian fauna adapted to this specialised habitat.

Many corticolous or subcorticolous carabids exhibit markedly depressed body shape and usually possess quite elongate tactile setae, but *Brigalowia* seems to reach the utmost status in both characters. This extremely adaptive body structure, however, rather impedes its classification into one of the many lebiine tribes and subtribes. Mostly by exclusion, *Brigalowia* seems best placed at present within Dromiini, because few structural characters argue against this arrangement and some characters, like the denticulate tarsi, shape of the palpi, and the structure of the male aedeagus, support it. However, I do not know of any dromiine species with comparative body shape, and the structure of the female stylomeres of *Brigalowia*, at least, accords better with Anomotarini (=Callidini) than with Dromiini. Hence, the actual systematic position of *Brigalowia* is still doubtful and its putative status within Dromiini is completely uncertain.

Additional sampling by use of pyrethrum bark fogging in other parts of Australia may show whether the species, or at least the genus, has a wider range through inland Australia.

ACKNOWLEDGEMENTS

I am very grateful to Geoff Monteith for loan of the specimens and for use of his photographs of gidgee trees. Geoff Thompson, also of the Queensland Museum, prepared the habitus illustration (Fig. 1).

LITERATURE CITED

BAEHR, M. 1992. Revision of the Pseudomorphinae of the Australian Region 1. The previous genera *Sphallomorpha* Westwood and *Silphomorpha* Westwood. Taxonomy, phylogeny, zoogeography (Insecta, Coleoptera, Carabidae). Spixiana Supplement 18: 1-440.

1995. Revision of *Philipis* (Coleoptera: Carabidae: Bembidiinae). A genus of arboreal Tachyine beetles from the rainforests of eastern Australia: taxonomy, phylogeny and biogeography. Memoirs of the Queensland Museum 38: 315-381.

1997. Revision of the Pseudomorphinae of the Australian Region 2. The genera *Adelotopus* Hope, *Cainogenion* Notman, *Paussotropus* Waterhouse, *Pseudomorpha* Kirby, and *Cryptocephalomorpha* Ritsema. Taxonomy, phylogeny, zoogeography (Insecta, Coleoptera, Carabidae). Spixiana Supplement 23: 1-510.

2002. New species and new records of Australian Pseudomorphinae. 4th Supplement to the "Revision of the Pseudomorphinae of the Australian Region." (Insecta, Coleoptera, Carabidae). Spixiana 25: 101-129.

2004. The Refuge under the Bark. German Research Special 2004: 62-65.

2005. The Amblytelini. A tribe of corticolous ground beetles from Australia. Taxonomy, phylogeny, biogeography (Insecta, Coleoptera, Carabidae, Psydrinae). – Coleoptera 8: 1-286.

PLATNICK, N. I. 2004. On a third group of flattened spiders from Australia (Araneae, Lamponidae) American Museum Novitates 3462: 1-7.

IN MEMORIAM
DR PETER WILLIAM ARNOLD

Dr Peter Arnold, Senior Curator, Museum of Tropical Queensland (1949 - 2006)

Dr Peter Arnold died suddenly at the age of 56 years on 7 March 2006. Peter possessed an exceptional knowledge of marine mammals and marine biology. He was loved, respected and admired by all family, friends and colleagues for his kindness, generosity, humility, dedication to his work and eagerness to help everyone at anytime. Everyone who knew Peter remembers him affectionately as a special individual, modest with brilliant intellect: a true gentleman.

Peter was born in Bridgewater, Nova Scotia, Canada on 14 May 1949, the son of John and Nora Arnold (both deceased) and brother of Diane Grant. He demonstrated a great interest in marine biology from an early age, and discomforted his family by bringing home specimens in varying stages of decomposition. Peter's early education consisted of a BSc (with Honors in Biology) at Acadia University, Canada, in 1970 and then a MSc (Aquatic Science) investigating parasites in Harbour porpoise (*Phocoena phocoena*) at the University of Guelph, Canada, in 1973 (Arnold, 1975). Peter moved from Canada to Townsville Australia in 1974, where, at the doorstep to the world's largest coral reef, his future in marine biology was secured. Pete began working on benthic invertebrates upon arrival to Townsville and obtained his PhD in 1979 from James Cook University (JCU). From 1979–1985, Peter was a Marine Biology Research Officer with JCU. Resulting from his impressive, multi-faceted knowledge of marine biology, Peter became an associate lecturer with the Department of Marine Biology at JCU from 1985–1987. Colleagues depended on 'googling' Pete's brain long before the internet offered an alternative.

In 1987, Peter became a Curator (later a Senior Curator) of Tropical Natural History, at the Museum of Tropical Queensland (MTQ). During his work at the museum, he furthered his interest in marine mammals, as well as many other aspects of marine biology. While working at the museum for nearly 20 years, Peter derived pleasure from almost every moment in life. He

would turn up at work every day, year in and year out. Although perceived as a 'workaholic', Peter was in fact driven by the inner contentment that came from each day's new findings. To Pete there were no weekends — only days when the dress-code was relaxed back to his trademark rubber thongs, he could hum over his work bench and maybe linger over coffee-time chats.

Soon after beginning work at the museum, Peter began his interest in the genus *Orcaella*, after initiating collaboration with Dr George Heinsohn, from JCU. George had collected the carcasses of coastal dolphins caught in shark nets off the Queensland coast since the late 1960s. Examination of specimens of what were then considered to be Irrawaddy dolphins (*Orcaella brevirostris)* resulted in the first detailed description of the morphology and taxonomy of this little known species (Arnold & Heinsohn, 1996). Peter quickly became an authority on Irrawaddy dolphins (Stacey & Arnold, 1999; Arnold, 2002), which eventuated into: 1) designation of a new dolphin species, the Australian Snubfin dolphin (*Orcaella heinsohni)* which is thought to be endemic to Australian and probably Papua New Guinea waters (Beasley et al., 2002, 2005), and 2) supervision of the first comprehensive study on the behavioral ecology of Australian Snubfin dolphins by Dr Guido Parra of James Cook University in 2005.

Peter also had a dedicated interest in Minke Whales (*Balaenoptera acutorostrata* sensu lato), which began when assisting in the collection of the carcass of an animal which had died after being trapped for several weeks in a reef lagoon in a region of the Great Barrier Reef (GBR) in the early 1980s. Peter was the first to notice differences in the Southern Hemisphere form of the minke, which resulted in two papers describing the specifics of this potentially new dwarf form in 1987 (Arnold et al., 1987, 2005). This minke population subsequently became the basis of a lucrative 'swim with minke' tourism industry in the Great Barrier Reef.

Some of Peter's most enjoyable moments were when he was out researching the dwarf minke whales on the northern GBR with his close associate and friend, Alastair Birtles, from JCU, along with a host of students and volunteers. Peter was instrumental in guiding the research that provided evidence for the new subspecies of diminutive minke whale (Arnold et al., 2005). He was also a leading member of the team which documented the behavior (Arnold et al., 2005), distribution (Arnold, 1997) and interactions of minke whales with swimmers. This information provided the science base for developing effective management of swim with minke tourism (Birtles et al., 2002; Valentine et al., 2004).

Peter had more than a decade long involvement with the Great Barrier Reef soft sediment surveys of the JCU Marine Biology Benthic Research Unit (BRU) 1976–1988. After completing his PhD he was a Research Officer for at least six years in the BRU and played a leading role in a decade of sampling along a cross-shelf transect off Townsville, working closely with Professor Michel Pichon and Alastair Birtles. A generation of JCU Marine Biology students were initiated into the mysteries and delights of GBR benthic sampling from the *RV James Kirby* by Peter and his colleagues. These shelf studies were significantly extended by three deep sea expeditions (CIDARIS I, II and III) aboard the CSIRO *RV Franklin* in 1986, 1988 and 1992. Initially funded by MSTGS, the project 'Deep-sea bottom fauna of the Great Barrier Reef Shelf and adjacent Coral Sea' collected a wide range of benthos from the GBR continental slope, Queensland Trench and ultimately to bathyal and abyssal depths of over 3,500 metres in the Gulf of Papua. These unique collections are now all deposited in the MTQ.

Peter also shared his encyclopedic knowledge of tropical benthos, benthic sampling, identification and analyses with a large group of international colleagues from Southeast Asia when he and Alastair co-organised the ASEAN-AIMS-AIDAB Soft Bottom Communities Workshops in 1985 and 1987. These formed a significant component of the AIDAB-funded ASEAN-AUSTRALIA Living Resources in Coastal Areas Project (part of the ASEAN-AUSTRALIA Economic Co-operation Program) which began with an intensive three month series of Methodology Workshops held in 1985 and subsequently involved several participants from each of the ASEAN countries in an extended Soft Bottom Communities Workshop in 1987. Peter formed a lasting series of friendships and professional collaborations as a result of his dedicated work for this project which was aimed at developing the scientific and technical expertise within the ASEAN region and established a regional database and an information exchange network throughout the ASEAN countries.

In his role as a 'guru' of the soft benthos, Peter most recently lead the MTQ team working on the CRC-Reef funded GBR Seabed Biodiversity

Mapping Project (GBR SBD). Though he did not live to see its culmination, this monumental project dealt with over 72,000 specimens split into at least 10,675 nominal species. Peter's role in processing the Townsville component of this collection was inspirational to all those who worked with him.

Peter took a particular liking and interest in the bryozoans ('lace corals' or 'moss animals'), and devoted much of his spare efforts to their study. He published a number of papers on the taxonomy and functional morphology of tropical soft sediment bryozoans, but also his identification capability met a vital national taxonomic need, and was widely utilised by the Australasian research community. But Peter was building to bigger and better things. Over the decades he and his co-workers had amassed a collection of many hundreds of species of bryozoans, in over 170 genera and in at least 76 families. Peter had done enough work on these collections to be able to say that they contained many new records for Australia, extended the ranges of many known species (many of which were previously known only from single specimens or limited material collected more than 100 years ago), and he had discovered 'a number' of undescribed species and genera. Peter was ready to ramp-up his productivity, and in one of his last communications to the Queensland Museum bureaucracy was that 'the major focus for the Tropical Natural History section at MTQ from mid 2006 will be on collection development and research on bryozoans', and that he was in the process of completing a number of papers on significant collections at MTQ. Although this research was sadly and abruptly halted, Peter and his team leave us a legacy in the form of an internationally significant, well-curated marine invertebrate collection that will without doubt be the basis of ongoing international taxonomic research.

To Peter, there was no question that did not have an answer and he would not rest until that answer was found. He loved to carry others along with him in this quest. One of his greatest pleasures, and a source of modest pride, was to guide and follow the achievements of the many students who joined him at various levels, from gifted high school volunteers to graduate research students. His thirst for knowledge was infectious and his generosity in sharing it was unbounded. Peter gave freely, his time and utmost energy to assist at least 19 students, primarily from JCU, to complete their research degrees with the careful dedication to precision and quality that characterised all his endeavors.

In 2005, Peter was awarded an adjunct position at the School of Tropical Environment Studies and Geography at JCU, for his dedication to students and their work. Amongst other things his students worked on the sustainable use of ecologically important natural resources by the tourism industry, acoustics, behaviour, and swim-with-whale minke tourism, behavioural ecology of coastal cetaceans in Queensland waters, and research and conservation of the Irrawaddy dolphin population inhabiting the Mekong River.

Despite Peter's primary focus on natural history, he never lost his interest in the day-to-day running of MTQ. Activities as diverse as education programmes, volunteer training, emergency procedures, exhibition content, children's holiday activities, and community resource networks, were based on planning and development by Peter. He was a true museologist and the MTQ is an enduring monument to his efforts.

During his 25 years of contributions to marine biology, Peter authored a variety of scientific publications, with topics ranging from collection of deep-sea fauna and identification of new species, with a particular focus on bryozoans (Arnold & Birtles 1989; Arnold, 1993; Lemmens et al., 1995; Arnold & Cook, 1997; Gordon & Arnold, 1998) to the largest cetaceans, namely the minke whale. An example of Peter's scientific integrity and humility was his reluctance to submit papers for publication until he was completely sure the content and writing was impeccable, or to be listed as coauthor in publications, even though he had a significant input. Throughout all his endeavors, and probably quite unknowingly, Peter captured the admiration and respect of his friends and colleagues.

At his sister's request, Peter's ashes were spread by friends on the waters of his beloved Great Barrier Reef during the 2006 minke whale season from the research and adventure tourism vessel *Undersea Explorer*. It was aboard this boat that Peter had shared over ten years of Minke Whale Project field work - and some of the happiest times of his life. We remember Peter with great affection as an exceptional human being, with astounding curiosity, persistence, intellect, generosity and humility. Peter's integrity and enthusiasm for science remain with his students and colleagues, whose lives were enriched by knowing him.

Vale by Peter's many friends, colleagues and students.

BIBLIOGRAPHY OF P.W. ARNOLD

ARNOLD, P.W. 1987. Observations on living colonies of *Retiflustra* spp. (Cheilostomata: Anasea) from the central Queensland shelf, Australia. Cahiers de Biologie Marine 28(1): 147–157.

1993. First record of etenophore *Coeloplana* (*Benthoplana*) *meteoris* (Thiel 1968) from Australia. Memoirs of the Queensland Museum 33(1): 16.

1997. Occurrence of dwarf minke whales (*Balaenoptera acutorostrata*) on the northern Great Barrier Reef, Australia. Report of the International Whaling Commission 47: 419–424.

2002. Irrawaddy dolphin *Orcaella brevirostris*. Pp. 652–654. Invited contribution to PERRIN, W.F., WURSIG, B. & THEWISSEN, J.G.M. (eds), Encyclopedia of Marine Mammals. Academic Press.

ARNOLD P.W. & BIRTLES R.A. 1985. Zoning the central section of the Great Barrier Reef Marine Park for the conservation and management of the soft-sediment areas of the continental shelf. Report submitted to the Great Barrier Reef Marine Park Authority, ii + 62 pp.

1986. Biological communities of the subtidal soft sediment shelf. In Johnson, D.P., Belperio, A.P. & Hopley, D. 1986. A field guide to mixed terrigenous-carbonate sedimentation in the Central Great Barrier Reef Province, Australia. Australasian Sedimentologists Group, Field Guide Series No 3. Geological Society of Australia, Sydney, pp. 27-30.

1989. Soft sediment marine invertebrates of southeast Asia and Australia: a guide to identification. Australian Institute of Marine Science, Townsville, Queensland. xxi + 272 pp.

1999. Towards Sustainable Management of the Developing Dwarf Minke Whale Tourism Industry in Northern Queensland. CRC Reef Research Centre Technical Report No. 27. Townsville; CRC Reef Research Centre. 30 pp.

ARNOLD, P.W., BIRTLES, R.A., DUNSTAN, A., LUKOSCHEK, V. & MATTHEWS, M. 2005. Colour patterns of the dwarf minke whale *Balaenoptera acutorostrata* sensu lato: description, cladistic analyses and taxonomic implications. Memoirs of the Queensland Museum 51(2): 277–307.

ARNOLD, P. W., BIRTLES, R.A., SOBTZICK, S., MATTHEWS, M. & DUNSTAN, A. 2005. Gulping behaviour in rorqual whales: underwater observations and functional interpretation. Memoirs of the Queensland Museum 51(2): 277–307.

ARNOLD, P.W. & COOK, P.L. 1997. Some recent species of the genus *Anaskopora* Wass, 1975 (Bryozoa: Cribriomorpha) from Queensland. Memoirs of the Queensland Museum 42(1): 1–11.

ARNOLD, P.W. & GASKIN, D.E. 1975. Lungworms (Metastrongyloidea: Pseudaliidae) of Harbour porpoise *Phocoena phocoena* (L., 1758) Canadian Journal of Zoology 53: 713–735

ARNOLD, P.W. & GEORGE, R.W. 1987. Recognition of *Leucosia whitei* Bell and *Leucosia cheverti* Haswell (Decapoda, Brachyura, Leucosiidae). Crustaceana (Leiden) 53(2): 209–214.

ARNOLD, P.W. & HEINSOHN, G.H. 1996. Phylogenetic status of the Irrawaddy Dolphin *Orcaella brevirostris* (Owen in Gray): a cladistic analysis. Memoirs of the Queensland Museum 39: 141–204.

ARNOLD, P.W., MARSH, H. & HEINSOHN, G. 1987. The occurrence of two forms of minke whales in east Australian waters with a description of the external characters and skeleton of the diminutive or dwarf form. The Scientific Reports of the Whales Research Institute 38: 1–46

BEASLEY, I., ARNOLD, P.W. & HEINSOHN, G. 2002. Geographical variation in skull morphology of the Irrawaddy Dolphins, *Orcaella brevirostris* (Owen in Gray, 1866). Raffles Bulletin of Zoology, Supplement: 15–34.

BEASLEY, I., ROBERTSON, K. & ARNOLD, P.W. 2005. Description of a new dolphin, the Australian Snubfin Dolphin *Orcaella heinsohni* sp.n. (Cetacea, Delphinidae). Marine Mammal Science 21(3): 365–400.

BIRTLES, R.A. & ARNOLD, P.W. 1983. Between the reefs: some patterns of soft-substrate epibenthos on the central Great Barrier Reef Shelf. pp. 159-163. In: Baker, J., Carter, R., Sammarco, P. & K. Stark (eds.). Proc. Inaug. Great Barrier Reef Conference, JCU Press.

1988. Distribution of trophic groups of epifaunal echinoderms and molluscs in the soft sediment areas of the central Great Barrier Reef Shelf. Pp. 325–332. In, CHOAT, J.H., BARNES, D., BOROWITZKA, M.A. & COLL, J.C. (eds), Proceedings of the Sixth International Coral Reef Symposium. Townsville, Australia. 8–12 August. Contributed Papers (Mini Symposium 11/16 to 22). Sixth International Coral Reef Symposium Executive Committee, 1988. Pp. 1–584.

BIRTLES, A.R., ARNOLD, P.W. & DUNSTAN, A. 2002. Commercial swim programs with dwarf minke whales on the northern Great Barrier Reef, Australia: Some characteristics of the encounters with management implications. Australian Mammalogy 24: 23–38.

BIRTLES, A., VALENTINE, P., CURNOCK, M., ARNOLD, P. & DUNSTAN, A. 2002. Incorporating visitor experiences into ecologically sustainable dwarf minke whale tourism in the

northern Great Barrier Reef. CRC Reef Research Centre Technical Report No. 42, CRC Reef Research Centre, Townsville. 65 pp.

GORDON, D.P. & ARNOLD, P.W. 1998. *Bryorachis* (Phidoloporidae) and *Retelepralia* (Cheiloporinidae): two new genera of the Indo-Pacific Bryozoa. Memoirs of the Queensland Museum 42(2): 495–503.

LEMMENS, J.W.T., ARNOLD, P.W. & BIRTLES, R.A. 1995. Distribution patterns and selective feeding in two *Astropecten* species (Asteroidea: Echinodermata) from Cleveland Bay, north Queensland. Marine and Freshwater Research 46: 447–455.

MARSH, H., ARNOLD, P.W., FREEMAN, M., HAYNES, D., KASUYA, T. & LAIST, D.W. 2003. Strategies for Conserving Marine Mammals. In, GALES, N., HINDELL, M. & KIRKWOOD, R. (eds), Marine Mammals and Humans: Towards a Sustainable Balance. CSIRO Publishing.

MARSH, H., ARNOLD, P.W., LIMPUS, C.J., BIRTLES, R.A., BREEN, B., ROBINS, J. & WILLIAMS, R. (1996). Endangered and charismatic megafauna, pp. 24-138 in Great Barrier Reef: Science, Use and Management, Volume 1. Proceedings of a Conference at James Cook University of North Queensland, Nov. 1996.

STACEY, P.J. & ARNOLD, P.W. 1999. *Orcaella brevirostris*. Mammalian Species. American Society of Mammalogists 616: 1–8.

VALENTINE, P.S., BIRTLES, R.A. CURNOCK, M., ARNOLD, P.W. & DUNSTAN, A., 2004. Getting closer to whales-passenger expectations and experiences, and the management of swim with dwarf minke whale interactions in the Great Barrier Reef. Tourism Management 25: 647–655.

LIST OF STUDENTS SUPERVISED

Doctoral Students

1. Gedamke, J. 2004. The acoustics of the Dwarf Minke Whale. PhD, USC. (Contributed informally but significantly)
2. Miller, D. 2005. Towards sustainable use of ecologically important natural resources by an economically important tourism industry in the Great Barrier Reef Marine Park. A study of the live-aboard dive industry in northern Queensland. PhD, JCU. (Contributed informally but significantly).
3. Parra, G.J. 2005. Behavioural ecology of Irrawaddy, *Orcaella brevirostris* (Owen in Gray 1866) and Indo-Pacific humpback dolphins, *Sousa chinensis* (Osbeck 1765) in northeast Queensland, Australia: a comparative study. PhD, JCU. (Co-supervisor with Helene Marsh and Peter Arnold).
4. Beasley, I.L. To complete. Behavioural and social considerations affecting conservation of the Irrawaddy dolphin, *Orcaella brevisostris* (Owen in Gary 1866) inhabiting the Mekong River. PhD, JCU (Co-supervisor with Helene Marsh and Thomas Jefferson).
5. Curnock, M. To complete. Mechanisms for assessing the sustainability of the swim-with-dwarf minke whales tourism industry on the Great Barrier Reef. PhD, JCU (Associate Supervisor with Alastair Birtles).
6. Mangott, A. To complete. Encounter / interaction behaviour of dwarf minke whales (*Balaenoptera acutorostrata* sensu lato) associated with the swim-with industry on the northern GBR. PhD, JCU. (Co-Supervisor with Alastair Birtles)
7. Sobtzick, S. To complete. Dwarf Minke Whale (*Balaenoptera acutorostrata* sensu lato) biology and implications for tourism management. PhD, JCU. (Co-Supervisor with Alastair Birtles)

Additional Postgraduate Student Projects (co-supervised either formally or informally)

1. Curnock, M. 1998. A comparison of Japanese and Non-Japanese scuba divers' experiences and perceptions of the Great Barrier Reef, with a focus on Dwarf Minke Whale-diver interactions. BAdmin (Tourism) Honours, JCU. 98 pp., 18 tables, 4 figs. & Appendices A-F.
2. Matsukura, Y. 1998. Japanese scuba divers on the Great Barrier Reef. MSc (Tourism), JCU. 71 pp. & Appendices A-E.
3. O'Neill, F. 2000. Ecologically Sustainable Management of Human-Minke Whale Interactions: Visitor Experiences with Dwarf Minke Whales in the Northern Great Barrier Reef. MSc (Tourism), JCU. 95 pp.
4. Smith, L. 2000. Evaluating Interpretation for Managing Dwarf Minke Whale – Human Interactions in the Great Barrier Reef. MSc (Tourism), JCU.
5. Simoes, A. 2001. Managing cetacean tourism: a comparison between whale-watching in the Azores (Portugal), Brazil and Australia. MSc (Tourism), JCU.
6. Komiya, M. 2002. Interpretation for Japanese ecotourists: a case study of swim-with minke whale tourism in

the GBR. MSc (Tourism), JCU.
7. Hasling, J. 2003. Meet the Minkes: creating an interpretation package which emphasizes personal connections between humans and whales. MSc (Tourism), JCU.
8. Hawthorn, D. 2003. Exploring the practical application of sustainability indicators for nature-based tourism. MSc (Tourism), JCU.
9. Sjursaether, G. 2003. Involving tourism operators in the ecologically sustainable management of their industry: Developing a Sightings Network for the GBR minke whale ecotourism industry. MSc (Tourism), JCU.
10. Vintges, T. 2003. Involving tourism operators in the ecologically sustainable management of their industry: developing a better understanding of minke whale behaviour during swim encounters. MSc (Tourism), JCU.
11. Sobtzick, S. 2004. Length measurements of dwarf minke whales in the northern GBR using underwater video-grammetry. BSc Hon (Marine Biology), Rostock University, GDR.
12. Mangott, A. 2004. The management of day boat operations in the dwarf minke whale swim-with industry in the northern GBR. MSc (Tourism), JCU.

A NEW GENUS AND SPECIES OF CYLAPINAE FROM NEW CALEDONIA WITH RE-ANALYSIS OF THE *VANNIUS* COMPLEX PHYLOGENY (HETEROPTERA: MIRIDAE)

GERASIMOS CASSIS AND GEOFF B. MONTEITH

Cassis, G. & Monteith, G.B. 2006 11 10: A new genus and species of Cylapinae from New Caledonia with re-analysis of the *Vannius* complex phylogeny (Heteroptera: Miridae). *Memoirs of the Queensland Museum* **52**(1): 13-26. Brisbane. ISSN 0079-8835.

A remarkable new genus and species of cylapine plant bug, *Kanakamiris krypton* (Insecta: Heteroptera: Miridae), are described from New Caledonia. The male and female genitalia are described and illustrated. The generic phylogeny of Cassis, Schwartz, and Moulds (2003) is re-analysed to include the new taxon, with additions and corrections, and a new sister-group relationship is established. The distribution of *Kanakamiris* is discussed in relation to theories on New Caledonia harbouring basal taxa. Its biology as a probable mycetophage is discussed. ❐ *Systematics, Miridae, Cylapinae, Vannius complex, Kanakamiris krypton, mycetophagy, New Caledonia, phylogeny, biogeography.*

Cassis, G. Australian Museum, 6 College St, Sydney 2010 Australia (School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney NSW 2052, Australia) (email: gerryc@austmus.gov.au); G.B. Monteith, Queensland Museum, PO Box 3300, South Brisbane, Qld 4101, Australia (email: geoff.monteith@qm.qld.gov.au); 1 July 2006.

The Cylapinae is a poorly studied subfamily of the speciose family Miridae (Insecta: Heteroptera). The classification, biogeography, and biology of this largely cryptozoic subfamily of plant bugs are little known (Schuh & Slater, 1995; Wheeler, 2000). Most biological information comes from label data, with many species found on the ground, in litter, under bark, or associated with mycelia or fruiting bodies of higher fungi (Wheeler, 2000; Cassis & Gross, 1995). Information on their feeding habits is limited, with generalisations about cylapine behaviour being based on just a handful of observations. Much has been made of their frequent occurrence in fungus-laden places, resulting in proposals of fungivory which, nevertheless, are supported by few direct observations (e.g. Schuh, 1976). Wheeler (2000) synthesised existing information on cylapine biology, suggesting that some Fulviini are predaceous. The undoubted basal position of the Cylapinae within the Miridae (Schuh, 1975, 1976) implies relictual distributions and plesiomorphic food-preferences.

The Cylapinae, although not greatly rich in species, particularly in comparison with the more diverse and largely arboreal subfamilies (Mirinae, Orthotylinae and Phylinae), is notably cosmopolitan, with greatest diversity in the Southern Hemisphere. Gorczyca (2000) reviewed the Afrotropical fauna, nearly doubling the species diversity for that region. In contrast, the Cylapinae of the Australian zoogeographic region are poorly documented. Cassis & Gross (1995) listed only 14 species from the Australian continent, but the diversity of unstudied cylapines in collections reveals a much richer fauna.

New Caledonia has been recognised as a biodiversity hotspot of global significance (Mittermeier et al., 2004), formerly sub-contiguous with Australia. Furthermore, many biotic elements of New Caledonia are ancient, and probably relictual; e.g. the flora includes diverse gymnosperms and many plesiomorphic angiosperm genera (Jaffré et al., 2001). Numerous New Caledonian taxa of Hemiptera are also probably relictual in distribution, e.g. *Notuchus* Fennah (Delphacidae; Donaldson, 1988), *Sagmation* Hamilton (Cicadellidae; Hamilton, 1999), *Oiophysella* Evans (Peloridiidae; Evans, 1982), *Monteithostolus* Štys (Enicocephalidae; Štys, 1981), *Schizopteromiris* Schuh (Miridae; Schuh, 1986), Targaremini (Rhyparochromidae; Distant, 1920) and *Gnostocoris* Kormilev (Aradidae; Monteith, 1980).

Queensland Museum entomologists have undertaken several expeditions to the main island (Grande Terre) of New Caledonia since 2000. These have revealed a species-rich and highly insular arthropod fauna, which is still poorly described. This includes a substantial cylapine fauna, belonging to both the Fulviini and the *Vannius* complex of the Cylapini. Prior to these modern collections, the only member of the latter suprageneric group recorded from New

Caledonia was *Vanniopsis rufescens* Poppius 1909. Cassis et al. (2003) reviewed the *Vannins* complex from the Australian Region and recorded a new genus, *Austrovannius*, from New Caledonia and Australia. It has numerous narrowly distributed species in New Caledonia, mostly from montane rainforest habitats, and most in preparation for publication. In addition, a remarkable and highly autapomorphic species of the *Vannius* complex that does not fit any existing genus, has been found in these collections. The aim of this paper is to describe this taxon and to reassess the generic phylogeny of the *Vannius* complex proposed by Cassis et al. (2003), including significant additions and corrections.

The fourth genus of the *Vannius* complex known in the Australian Region is *Vanniinsoides* Carvalho & Lorenzato, recorded from Fiji, Solomons, New Guinea and Queensland by Cassis et al. (2003). There are specimens of this genus in the Queensland Museum from the southern extremity of New Caledonia (unpubl.). This means that the island has all four genera, the only land mass in the world with this level of generic diversity.

MATERIALS AND METHODS

This study is based on 34 Queensland Museum specimens. The holotype is deposited in the Muséum National d'Histoire Naturelle, Paris (MNHN). Paratypes are deposited in the Queensland Museum, Brisbane (QM) and the Australian Museum, Sydney (AM).

Morphological terminology follows that given by Cassis (1995) and references therein. Terminology for the male genitalia does not follow that given by Kerzhner and Konstantinov (1999), such that the subdivision of the endosoma into conjunctiva and vesica is regarded as debatable. Light microscope observations were made using a Leica MZ16 stereomicroscope and a Leica DMB compound microscope.

Scanning electron micrographs were prepared with a Cambridge scanning electron microscope using techniques outlined in Bolte (1996) and Swearingen et al. (1997).

For the phylogenetic analysis, the data were assembled using MacClade 4.03 (Maddison & Maddison, 2001) and analysed using PAUP* version 4.0b10 (Swofford, 2002). Exhaustive searches were made using unweighted, successive weighted (rescaled consistency index), and implied weights (Goloboff fit criterion K=2). The same outgroups used in Cassis et al. (2003) were used in this analysis (*Bothriomiris lugubris* Poppius, *Peritropis bituberculata* Carvalho & Lorenzato and a species of *Cylapocerus* Carvalho). Multistate characters were coded as unordered. Nodal support was calculated using bootstrap resampling with 1000 replicates.

SYSTEMATICS

Kanakamiris gen. nov.

ETYMOLOGY. The genus refers to a local name for the indigenous peoples of New Caledonia – the *kanaks*, combined with the standard root from the family name *–miris*.

TYPE SPECIES. *Kanakamiris krypton* sp. nov., here designated.

DIAGNOSIS. The genus is recognised by the following attributes: elongate, macropterous (Fig. 1); head porrect, ant-like (Fig. 2A); vertex with longitudinal sulcus (Fig. 2A); bicompressed, sub-elliptoid labrum (Fig. 2B); compressed gula, with ridge-like midline (Fig. 2B); labium short, LI surpassing buccula; AI elongate, AII banded, AIII and AIV threadlike (Fig. 1); eyes enlarged, contiguous with anterior margin of pronotal collar (Figs 1, 2A); pronotum campanulate (Figs 1, 2C); pronotal collar enlarged, raised (Figs 1, 2C); scutellum medially tumose (Fig. 1); R+M and median flexion line contiguous (Fig. 1); elaval commissure elongate (Fig. 1); cuneus narrow (Fig. 1); external efferent system of metathoracic glands well developed (Fig. 2D); peritreme anterior in orientation (Fig. 2D); metathoracic spiracle visible (Fig. 2D); tarsi two-segmented; genital opening of male pygophore dorsal in orientation (Fig. 3A); parameres simple, weakly arcuate (Figs 3B-C); aedeagus sac-like with three ribbon-like basal processes (Figs 3D-E); secondary gonopore ring-like, prominent, with distal duct (Fig. 3D).

DESCRIPTION. Structure: Macropterous males (Fig. 1) and females; body elongate. Head: ant-like, porrect, greatly elongate, longer than wide (Fig. 2A); moderately declivent (Fig. 2B); vertex narrow, with weak, shallow medial sulcation (Fig. 2A); frons conical, convex in profile (Figs 2A-B); clypeus short, conical, coplanar with frons (Fig. 2B); mandibular plate large, subtriangular (Fig. 2B); buccula very short, margins rounded (Fig. 2B); labrum enlarged, greatly bicompressed, subelliptoid, platelike (Fig. 2B); gula strongly bicompressed, with medial impressed margin (Fig.

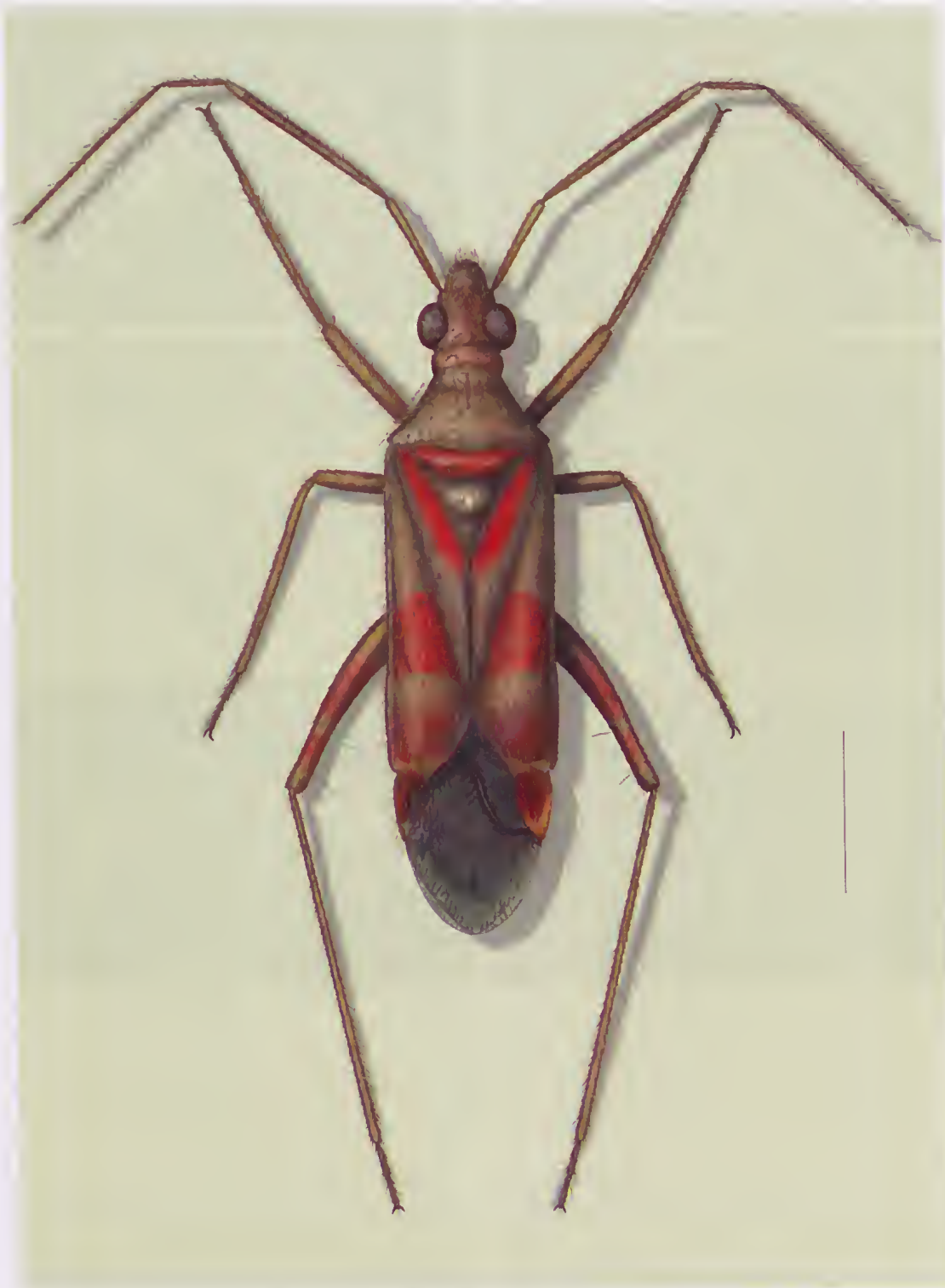


FIG. 1. *Kanakamiris krypton* gen. et sp. nov., dorsal view of male. Illustration by Geoff Thompson.

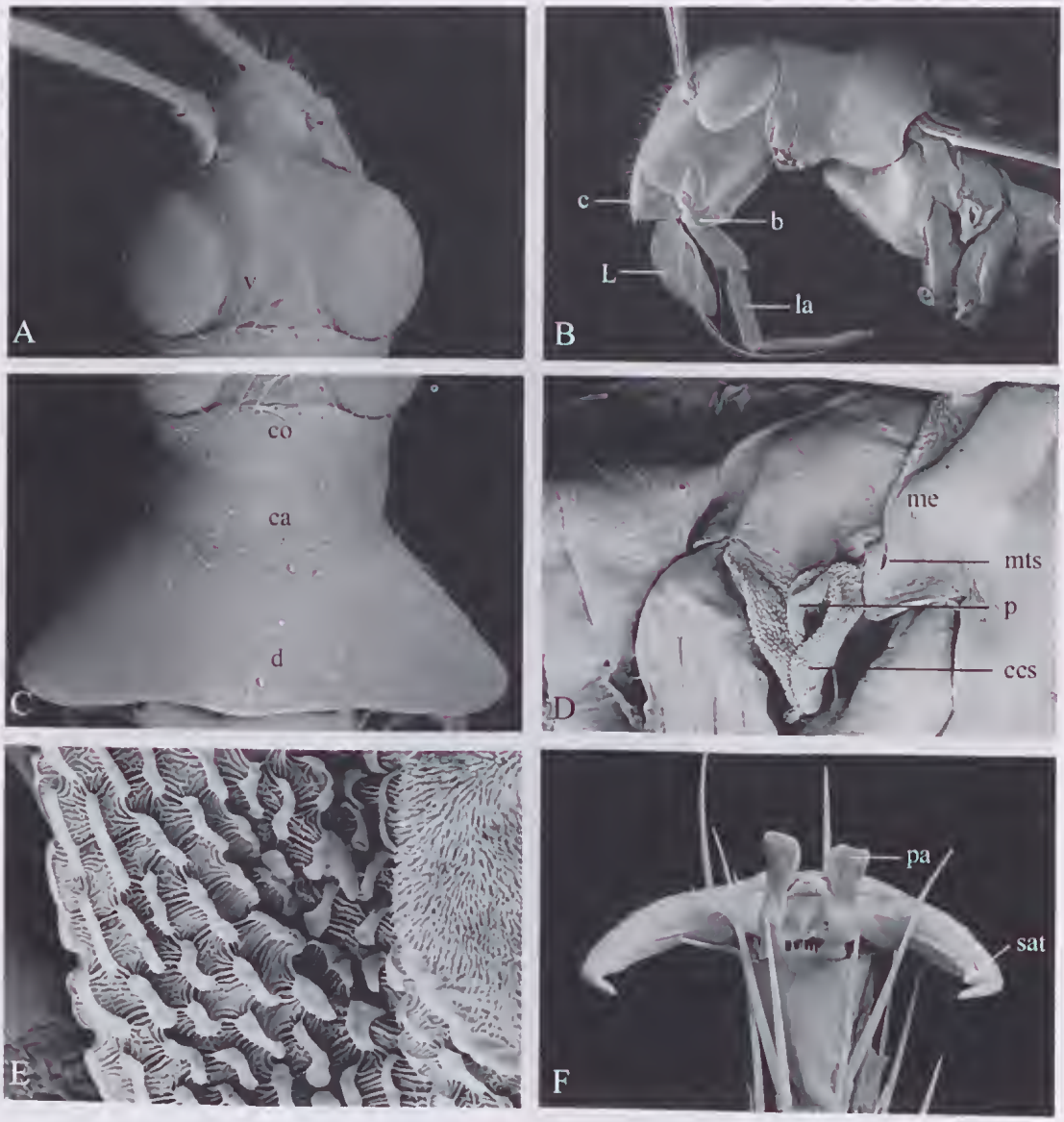


FIG. 2. *Kanakamiris krypton* gen. et sp. nov., external morphology. A, head, dorsal view; B, head and thorax, lateral view; C, prontoum, dorsal view; D, thoracic pleura, lateral view; E, evaporative areas of metathoracic glands; F, pretarsus, ventral view. Abbreviations: b, bucculae; c, clypeus; ca, callosite region of pronotum; co, pronotal collar; d, discal region of pronotum; ees, external efferent system; L, labrum; la, labium; me, mesepimeron; mts, metathoracic spiracle; p, peritreme of external efferent system; pa, parempodium; sat, subapical tubercle; v, vertex.

2B); labium thick, relatively short, reaching apices of mesocoxae (Fig. 2B); LI short, just surpassing bucculae posteriorly; eyes greatly enlarged, mostly dorsally oriented, contiguous with anterior margin of pronotal collar (Figs 1, 2A-B). Antennae: relatively thin and elongate, with AIII and AIV threadlike; AI elongate, narrowly vasiform, longer than interocular distance; AII weakly expanded distally, a little longer than posterior width of pronotum (Fig. 1). Pronotum: campanulate, lateral margins strongly expanded posteriorly (Figs 1, 2C); collar greatly enlarged, rounded, raised above callosite region (Figs 1, 2C); disc moderately rounded; posterior

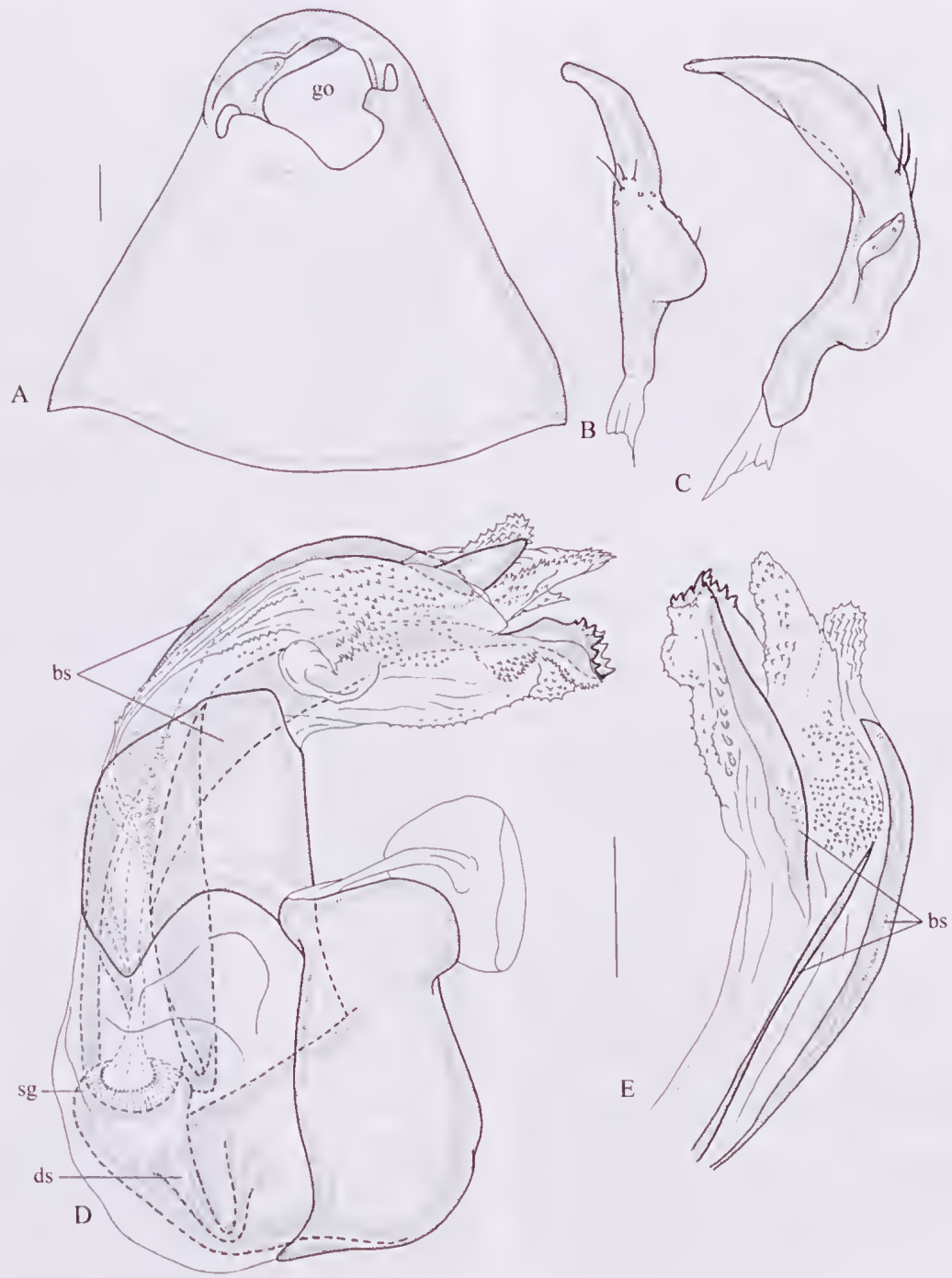


FIG. 3. *Kanakamiris krypton* gen. et sp. nov., male genitalia. A, male pygophore, dorsal view; B, right paramere, lateral view; C, left paramere, lateral view; D, aedeagus, lateral view; E, apex of endosoma, ventral view. Abbreviations: bs, basal sclerite; ds, ductus seminis; go, genital opening of male pygophore; sg, secondary gonopore.

margin of dise weakly bisinuate (Figs 1, 2C). Mesoseutum: exposed, moderately eonvex (Fig. 1). Seutellum: medially tumose, laterally flattened (Fig. 1). Mesepimeron: moderately developed, metathoracic spiracle visible, with evaporative areas on postalare margin (Fig. 2D). Mctathoracic glands: external efferent system well developed, oecupying more than ⅓ of metepisternum, reaehing mesepimeron in lateral view (Fig. 2D); peritreme anteriorly oriented, tongue-like (Fig. 2D); evaporative bodies with elongate caps (Fig. 2E). Legs: elongate, linear; tarsi two-segmented, both segments elongate; parempodia flattened, spatulate-like (Fig. 2F). Hemelytra (Fig. 1): elavus prominent, eommissure longer than anteromedial margin of clavus; median flexion linc elongate, reaching midpoint of elaval commissure, partly eontiguous with R+M vein; euneus elongate, narrow; two membrane eells present, minor eell very narrow, elongate. Male genitalia: genital opening of male pygophore dorsal in orientation (Fig. 3A), suboval; parameres roughly equal in size; right paramere, smaller than left, weakly arcuate, tapered distally (Fig. 3B); left paramere weakly arcuate, with flange near base of shaft, tapered distally (Fig. 3C); aedeagus sae-like with three ribbon-like basal processes; apex of one membraneous lobe with selerotised, serrate margin (Figs 3D-E); secondary gonopore ring-like, prominent, with attached, distal duct (Fig. 3D); ductus seminis short, heavily selerotised, without hose-like substructure (Fig. 3D). Female genitalia (Fig. 4): dorsal labiate plate with simple, symmetrical, sclerotised rings; dorsal surface of common oviduct granulate; posterior wall of bursa copulatrix simple, obscurely bilobed, with dorsal and lateral margins of inter-ramal sclerites selerotised; without inter-ramal lobes.

REMARKS. This genus is distinct amongst the *Vannius* complex in possessing the highly autapomorphic head (head porrect, ant-like; bicompressed labrum; pinched gula). The body has disruptive colouration patterning more reminiscent of that found in species of *Vanniusoides* and *Vannius*, than the spotted appearance of *Austrovannius* species. However, *Austrovannius* and *Kanakamiris* share the presence of a ring-like secondary gonopore.

Kanakamiris krypton sp. nov.
(Figs 1-4)

ETYMOLOGY. This species is named after its eryptozoic habitus; from the Greek *kryptos*, meaning hidden.

MATERIAL. NEW CALEDONIA, PROVINCE NORD: HOLOTYPE ♂, 21°09'S × 165°19'E, Aoupinié sawmill, 500m, 2.i.2005, G.B. Monteith, beating, rainforest, [11984] (MNHN); PARATYPES. NEW CALEDONIA, PROVINCE NORD: 2♂1♀, same data as holotype (AM); 3♀, 20°58'S, 165°17'E, Pic d'Amoa, N. slopes, 500m,10-24.xi.2001, C.J. Burwell & G.B. Monteith, malaise trap, [8683] (AM); 1♀, 20°58'S, 165°17'E, Pic d'Amoa, summit, 600m, 26.xi.2003, G.B. Monteith, pyrethrum, trees & logs, [11436] (AM); NEW CALEDONIA, PROVINCE SUD: 3♂ 4♀, 22°19'S, 166°55'E, Forêt Nord, Site 1, 480m, 9.i.2005, G.B. Monteith, beating cut branches of *Podocarpus* sp. FN1/2, [12080] (AM & QM); 2♂♀4, same data but beating cut branches of Cunoniaceae FN1/3, [12081] (QM); 1♂1♀, same data but beating cut branches of *Styphelia* FN1/1, [12079] (AM); 2♂4♀, same locality, 22.xii.2004 - 9.i.2005, Burwell & Wright, malaise trap, rainforest, [12074] (AM & QM); 1♀, same locality, 2-3.xii.2004, C.J. Burwell & G.B. Monteith, pyrethrum, [11822] (QM); 1♂, 22°17'S, 166°53'E, Pic du Grand Kaori, Site 2, 250m, 21.xii.2004 - 12.i.2005, Wright & Burwell, malaise trap, rainforest, [12030] (AM); 2♂, 22°17'S, 166°53'E, Pic du Grand Kaori, Site 1, 250m, 22.xii.2004 - 12.i.2005, Burwell & Wright, malaise trap, rainforest, [12020] (AM); 1♀, 22°14'S, 166°50'E, Pic du Pin, Site 2, 280m, 12.i.2005, G.B. Monteith, beating cut branches of PP2/3, [12054] (QM). (Numbers within square brackets are collection sample codes used by the Queensland Museum).

DIAGNOSIS. This species is recognised by the following eharaeters: trieoloured body, mostly orange-brown with white and red markings (Fig. 1); Al narrowly vasiform, longer than interoeular distanee (Fig. 1); All banded (Fig. 1); AIII very short (Fig. 1); fourth labial segment very short; metafemora banded (Fig. 1); and, female abdominal venter with lateral red markings.

DESCRIPTION. Colouration (Fig. 1): Body trieoloured, ground colour yellow to orange-brown, with white and red to reddish brown markings. Head, mostly pale orange-brown, sometimes with red highlighting; bueculae and labrum mostly red. Labium: LI red; LII-LIV orange-brown. Antennae: Al orange-brown; All proximal two fifths orange-brown, medially dark reddish brown, and tip with white annulation; AIII and AIV dark reddish brown. Pronotum: eollar pale red; callosite region white; dise pale red, often darker

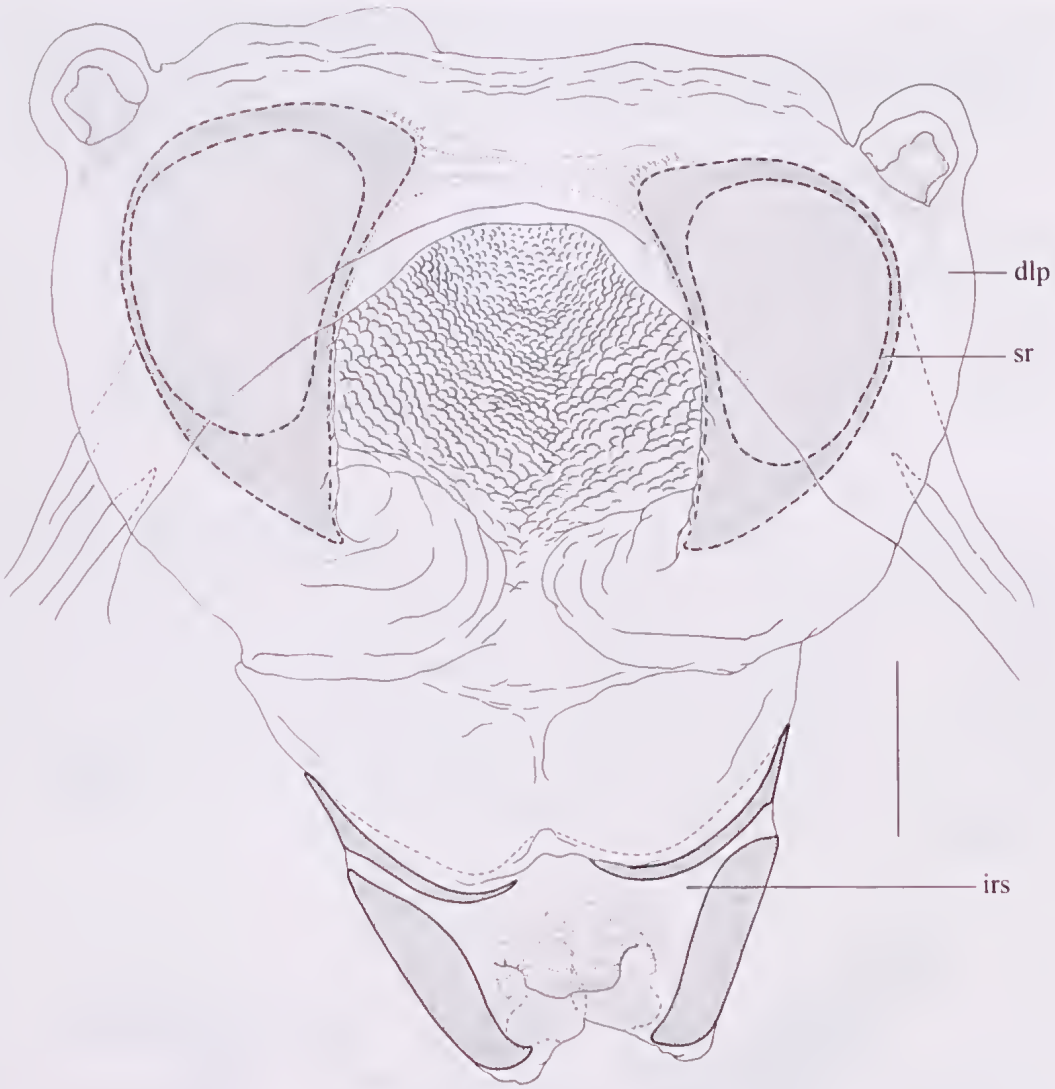


FIG. 4. *Kanakamiris krypton* gen. et sp. nov., female genitalia. Abbreviations: dlp, dorsal labiate plate; irs, interramal selerite; sr, selerotised rings.

laterally. Thoraeic pleura: proepisternum white, remainder red. Mesoseutum: red, sometimes with dusty appearanee; lateral margins narrowly yellow. Seutellum: tumose medial region mostly yellow, often with dusty highlighting; laterally grey. Hemelytra: clavus proximal ½ mostly red (narrowly white laterally), medially translucent white, distal ⅓ orange-brown; eorium proximally translucent white, broad medial red band, more distally with translueent white band, and apically with broad reddish brown band. Legs: fore and middle legs mostly yellowish brown, sometimes with weak red highlighting; hind femora banded, mostly pale red, with subapieal and apieal orange-brown annulations; metatibiae mostly red, basally and apieally yellowish brown to orange-brown; tarsi mostly brown, sometimes paler proximally. Abdominal venter: female most often yellowish brown, SVI-XIII with lateral dark reddish brown marking, sometimes with broad red infuscation; male pregenital abdominal venter orange-brown with red to dark reddish brown highlighting, pygophore mostly orange-brown, with ventral region adjaeent to genital opening fuscous.

Vestiture. Dorsum with moderately dense eovering of simple, deeumbent to erect setae, paler and

TABLE 1. Measurements of external characters of males and females of *Kanakamiris kryptons*. Abbreviations: BL, body length; C-CL, clypeal to cuneal length; HL, head length; PL, pronotal length; CL, cuneal length; HW, head width; PW, pronotum width; SW, scutellum width; IOD, interocular distance; AI, first antennal segment length; AII, second antennal segment length; AIII, third antennal segment length; and, AIV, fourth antennal segment length.

	BL	C-CL	HL	PL	SL	CL	HW	PW	SW	IOD	AI	AII	AIII	AIV
Males														
Mean	4.05	2.87	0.29	0.62	0.47	0.51	0.67	1.07	0.42	0.29	0.64	1.27	0.41	0.78
Standard Deviation	0.05	0.18	0.07	0.05	0.04	0.04	0.02	0.12	0.00	0.02	0.06	0.14	0.08	0.12
Range	0.09	0.32	0.13	0.09	0.09	0.07	0.04	0.24	0.01	0.04	0.11	0.25	0.15	0.25
Minimum	3.99	2.66	0.23	0.58	0.44	0.48	0.65	0.95	0.42	0.27	0.60	1.19	0.32	0.65
Maximum	4.08	2.99	0.36	0.68	0.52	0.55	0.69	1.19	0.43	0.31	0.71	1.44	0.47	0.89
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Females														
Mean	4.50	3.46	0.38	0.70	0.49	0.51	0.71	1.17	0.45	0.24	0.72	1.39	0.56	0.96
Standard Deviation	0.26	0.21	0.06	0.03	0.05	0.06	0.03	0.06	0.04	0.03	0.07	0.10	0.09	0.31
Range	0.68	0.50	0.15	0.07	0.12	0.14	0.07	0.13	0.11	0.07	0.16	0.26	0.21	0.63
Minimum	4.14	3.16	0.30	0.67	0.42	0.42	0.68	1.11	0.39	0.21	0.62	1.28	0.43	0.67
Maximum	4.82	3.66	0.45	0.74	0.55	0.56	0.74	1.24	0.50	0.28	0.78	1.54	0.64	1.30
n	5	5	5	5	5	5	5	5	5	5	5	5	4	5

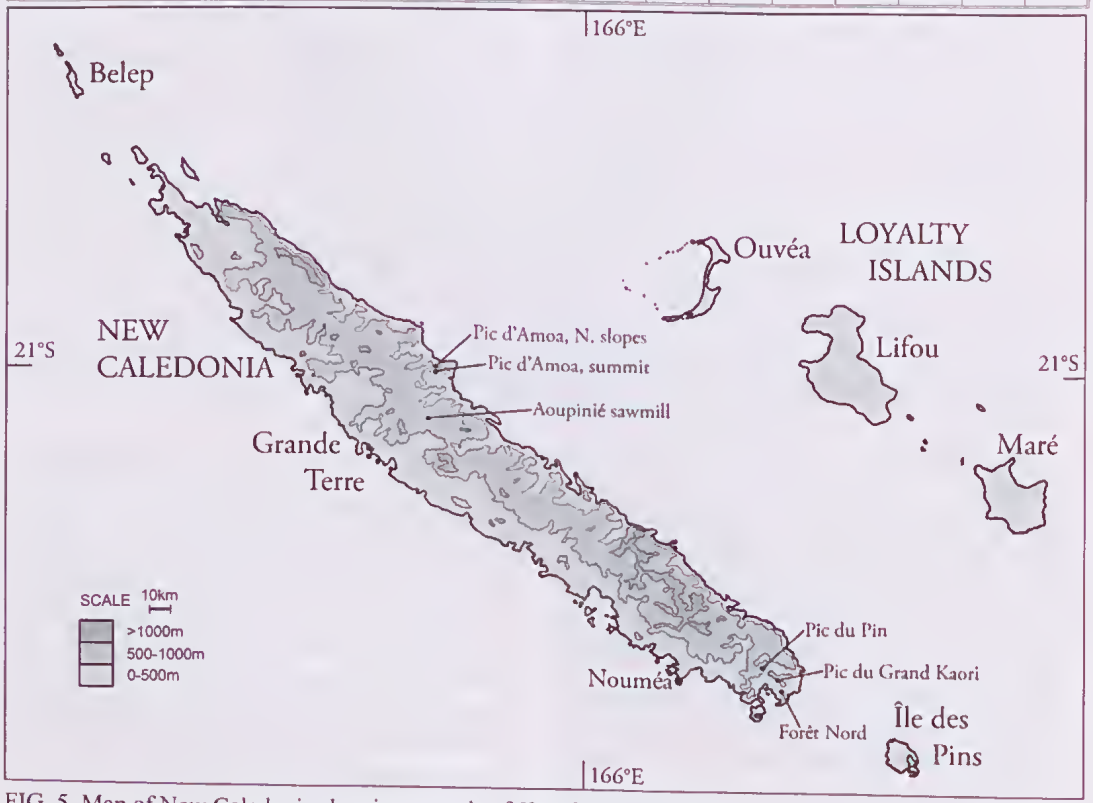


FIG. 5. Map of New Caledonia showing records of *Kanakamiris krypton*.

more erect on head, remainder mostly fuscous. Antennae and legs with dense distribution of short, semi-erect, simple setae.

Structure. Dorsum impunctate, granulose; appendages moderately elongate. Antennae: AI much longer than interocular distance; AII a little longer than width of posterior margin of pronotum; AIII very short, shortest segment; AIV longest segment, a little longer than AII. Labium: LIII longest segment, a little longer than both LI and

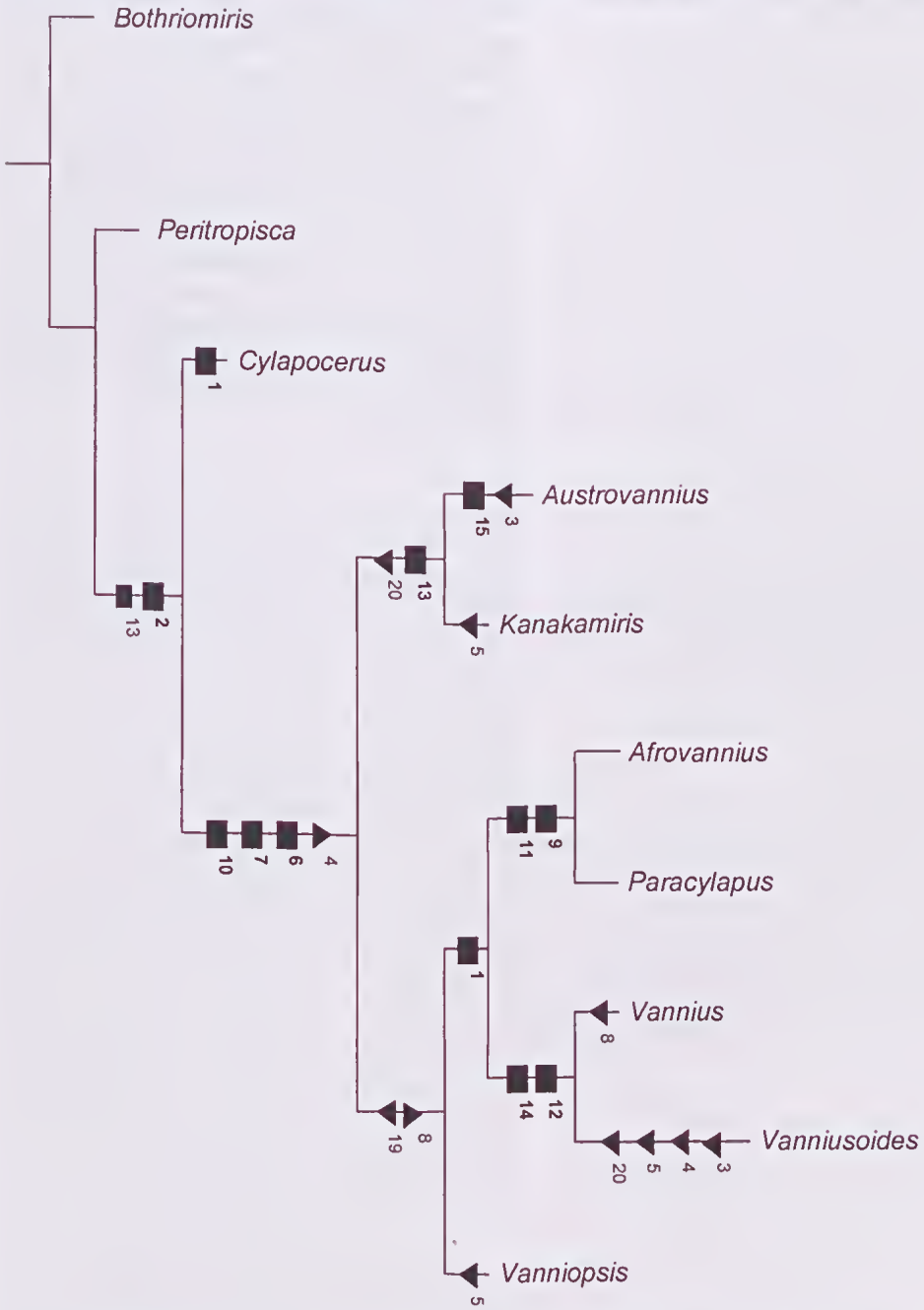


FIG. 6. Cladogram of genera of *Vannius* complex. Synapomorphies = large black squares; synapomorphy unclear = small black square; forward homoplasy = black triangle; back homoplasy = inverse triangle. Bootstrap values given at nodes.

TABLE 2. Characters and character states of the *Vannius* complex and outgroups.

1. Head orientation: horizontal (0); dorsoventral (1); ventral (2).
2. Frons and clypeus: bilobed (0); coplanar (1).
3. Vertex sulcation: absent (0); present (1).
4. Antennal shape: not thread-like (0); threadlike (1).
5. Antennal segment I: shorter or subequal to head length (0); significantly longer than head length (1).
6. Pronotal collar: absent (0); present (1).
7. Disruptive colouration: absent (0); present (1).
8. Metafemora: moderately elongate (0); greatly elongate (1).
9. Pretarsal claw subapical teeth: absent (0); one pair (1); two pair (2).
10. Parempodia: setiform (0); spatulate (1).
11. Left paramere size: elongate (0); short (1).
12. Aedeagus shape: broad (0); narrow (1).
13. Secondary gonopore: undifferentiated (0); simple aperture (1); ring-like aperture (2).
14. Secondary gonopore: proximal (0); distal (1).
15. Endosomal apex: not serrate (0); serrate (1)
16. Sclerotised rings: thin (0); thick (1).
17. Ventral labiate plate: separated medially (0); joined anteriorly (1).
18. Dorsal labiate plate: not expanded lateral of sclerotised rings (0); expanded lateral of sclerotised rings, lateral-most margins scroll-like (1).
19. Inter-ramal sclerite: divided, with two thin sclerites (0); spanning base of first valvifer (1).
20. Inter-ramal lobes: absent (0); present (1).

LII; LIV very short. Male and female genitalia as in generic description.

MEASUREMENTS. See Table 1.

DISTRIBUTION (FIG. 5). All six collection localities are in high-rainfall rainforest areas at medium altitudes from 250 to 600m. The localities fall into two disjunct groups, three at the southern extremity of the Grande Terre, and three clustered about 200km further north in the northern half of the island. This apparent pronounced disjunction may be genuine because the Queensland Museum has sampled, using similar methods at more than 200 localities throughout the island. Many of the negative localities are similar in vegetation and altitude (Col d'Amieu, Monts des Koghis, Mandjélia) and have been sampled much more intensively. All positive localities lie within nature reserves.

REMARKS. *Kanakamiris krypton* is highly autapomorphic, differing from other species of the *Vannius* complex in possessing a platelike labrum. Its disruptive colouration is unlike *Austrovannius* species, and more like all the other genera of the *Vannius* complex in possessing broad rectangular red markings on the dorsum. The very short third antennal segment of *K. krypton* is unlike other species of the *Vannius* complex, and is a strong diagnostic marker.

TABLE 3. Character matrix of three outgroups (*Bothriomiris lugubris*, *Peritropisca bituberculata* and *Cylapocerus* sp.) and six genera of the *Vannius* complex and eleven characters. Missing data = ?

Character #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Bothriomiris	0	0	0	0	0	0	0	0	0	?	0	0	0	?	0	?	?	1	1	0
Peritropisca	0	0	1	0	0	0	0	0	0	0	0	0	0	?	0	?	?	0	0	1
Cylapocerus	1	1	1	0	0	0	0	?	0	0	0	0	1	0	0	?	?	?	?	1
Afrovannius	2	1	1	1	0	1	1	1	2	1	1	0	1	0	0	?	?	?	?	?
Austrovannius	0	1	1	1	1	1	1	0	1	1	0	0	2	0	1	0	0	1	1	1
Kanakamiris	0	1	1	1	1	1	1	0	1	1	0	0	2	0	1	0	0	1	1	1
Paracylapus	2	1	1	1	0	1	1	1	2	1	1	0	1	0	0	?	?	?	?	?
Vanniopsis	0	1	1	1	1	1	1	1	1	1	0	0	1	?	0	0	1	0	0	0
Vannius	2	1	1	1	0	1	1	0	1	1	0	1	1	1	0	?	?	?	?	?
Vanniusoides	2	1	0	0	1	1	1	1	1	1	0	1	1	1	1	0	1	0	0	0

PHYLOGENETICS

The phylogeny of the genera of the *Vannius* complex presented here is based on an analysis of 20 morphological characters. The characters and character states are given in Table 2 and the data matrix in Table 3. A single tree was found, of the same topology and tree length (34 steps) for the unweighted, successive weighting and implied weights analyses. The tree statistics are as follows: consistency index of 0.68 and retention index of 0.70, and all nodes have a bootstrap value equal to or above 66%.

The cladogram is given in Fig. 6. Its topology differs substantially from that presented by Cassis et al. (2003). *Vanniopsis* is now more basal to the Afrotropical (*Afrovannius* and *Paracylapus*) and Neotropical (*Vannius*) genera, and no longer sister to *Vanninsoides* which is now sister-taxon to *Vannius*. In both trees, *Austrovannius* is the most basal taxon, but now is also sister to the new genus *Kanakamiris*.

The monophyly of the *Vannius complex* is supported by a 98% bootstrap value and three synapomorphies: pronotal collar present (6-1); disruptive colouration (7-1) and spatulate parempodia (10-1). Cassis et al. (2003) provided additional support in terms of the coplanar frons + clypeus and elongate metafemora, but the former character state is true of other members of the Cylapini, and the latter character is variable within the ingroup. The spatulate parempodia appears to be the most reliable synapomorphy for the group.

The *Austrovannius* + *Kanakamiris* clade is supported by a single synapomorphy (ring-like secondary gonopore; 13-2) and a homoplasy (presence of inter-ramal lobes, 20-1). Clearly, these two genera are not relatives, with *Austrovannius* greatly reduced and highly autapomorphic (pinched ventral margin of pygophore, tarsal claws without subapical teeth, and complex male aedeagus). Likewise, *Kanakamiris* is very distinctive, particularly in relation to the porrect head, bicompressed labrum and gula, and inerassate scutellum. However, the sister-taxon relationship of these sympatric genera is supported by sufficient data and moderately high bootstrap support (74%).

The monophyly of the remaining genera of the *Vannius* complex ((*Vanniopsis* + ((*Vanninsoides* + *Vannius*) + (*Afrovannius* + *Paracylapus*)))) is supported by a high bootstrap value (82%) and two homoplasies, viz. greatly elongate metafemora (8-1) and the divided inter-ramal sclerite (19-0). Within this clade *Vannius* also has relatively smaller metafemora, although this character system requires closer examination across all the species in the *Vannius* complex. The same is true of the shape of the inter-ramal sclerite, which has not been examined in *Afrovannius*, *Paracylapus* and *Vannius*.

The ((*Vanninsoides* + *Vannius*) + (*Afrovannius* + *Paracylapus*)) clade is supported by the lowest bootstrap value (66%) and a single synapomorphy (ventrally oriented head; 1-2). The Afrotropical genera *Afrovannius* + *Paracylapus* form a strongly supported clade, with high bootstrap value (85%) and two synapomorphies (pretarsal claws with two pairs of subapical teeth, 9-2, and the short left paramere, 11-1). The *Vannius* + *Vanninsoides* clade is also robust, with a high bootstrap value (83%) and two synapomorphies (narrow aedeagus, 12-1; secondary gonopore distal, 14-1).

BIOLOGY

Some information about the biology of *K. krypton* can be derived from the collecting methods and label data. Most (26) of the 34 specimens were taken during the course of an intensive insect survey of 8 rainforest sites at the southern end of the island in the summer (Nov to Jan) of 2004–2005 (Monteith et al., 2006). A range of 14 collecting methods was used at each site in a standard manner during the survey. The site where the mirids were commonest (15) was the 480m summit of Forêt Nord (Fig. 7A), which was the wettest site surveyed, with cloud often persistent. The only methods that yielded *K. krypton* specimens were, in order of success: beating cut branch traps (16), malaise trap (9) and pyrethrum spraying of tree trunks (1). None were collected by other methods such as light traps, leaf litter extracts, sweeping and beating foliage, all of which yield other species of Miridae.

'Cut branch traps' were made from batches of freshly cut, leafy branches, tied up into tight bundles with wire, and hung in the forest to wilt and decay in the natural weather. Each bundle comprised branches of only one tree species and three different species were hung at each site. The object of these traps is to collect beetles, such as longicorns and weevils, which come to dying vegetation. The traps were set in early December (end of the dry season) and were sampled by beating (Fig. 7B) about every week

FIG. 7. A, Interior of rainforest at summit of Forêt Nord. B, Beating a cut branch trap to collect *Kanakamiris krypton*. Photographs by Jeff Wright, QM.

until mid-January, after the summer rains had started. No *Kanakamiris* were taken during the December samplings, when the leaves were dry and withered. But in January, after the rains had started, the leaf bundles had a strong smell of mouldy decay and, in the centre, the leaves were black with mildew. At the Forêt Nord site, every bundle produced large numbers of the bugs, though few were collected because they ran and flew with great agility when they fell to the beating sheet. Clearly there was no association with a particular plant species because the leaf bundles comprised a gymnosperm (*Podocarpus* sp.) and angiosperms of two contrasting families, Epacridaceae (*Styphelia* sp.) and Cunoniaceae.

The only other method to catch significant numbers were malaise traps, which trap insects dispersing by flight through the lower storey of the forest. We believe this sampling evidence supports the view that *Kanakamiris* are mycetophages which fly through the forest in search of fallen, mouldy leafy branches, which are a common occurrence in rainforests during the stormy wet season. This augments other published evidence (see introduction) that Cylapini (including the *Vannius* complex) are primarily fungal feeders. The possibility that they feed on other myecetophagous insects also needs to be tested.

DISCUSSION

The basal sister-group relationship of the New Caledonian genera *Austrovannius* and *Kanakamiris* established in this work, suggests a biogeographically significant relictual distribution. As suggested by others, New Caledonia has a disproportionate number of basal taxa, both plant and animal, which are indicative of relics (Jaffré et al. 2001; Edgecombe 2003). Within the *Vannius* complex, the abovementioned genera are clearly differentiated from all others of the supragenerie group, particularly by the ring-like secondary gonopore. The more 'up-tree' genus *Vanniopsis* is also found in New Caledonia, with the type species, *V. rufescens* Poppius found in New Caledonia as well as Vanuatu, the latter a place of more recent biogeographic

connections (Raven & Axelrod 1972). In this work, *Vanniopsis* is established as the sister-taxon to *Vanniusoides* + *Vannius*, with both of the former genera having continental Australia + Melanesian distributions (Cassis et al., 2003). On the basis of this analysis, the presence of *Vanniopsis* in New Caledonia, however results in significant biogeographie paralogy, sueh that ambiguity exists as to whether New Caledonia is basal to other circumtropieal regions of the world.

ACKNOWLEDGEMENTS

Mr Geoff Thompson is thanked for the superb whole-inseet illustration (Fig. 1). Ms Hannah Finlay dissected the male and female genitalia and provided the detailed illustrations. Ms Sue Lindsay took the seanning electron mierographs. Ms Celia Symonds assisted with the preparation of the graphieal plates and took the measurements. Mr Nik Tatarnie rceorded the measurements and read the manuscript. Dr Chris Burwell, Mrs Susan Wright and Mr Peter Grimbaeher assisted with the eolleetion of material and Mr Jeff Wright took field photographs. Field work in southern New Calcdonia 2004-05 was part of an inseet inventory by the Queensland Museum funded by the Direction des Ressources Naturelles, Noumea.

LITERATURE CITED

BOLTE, K.B. 1996. Teehniques for obtaining scanning eleetron mierographs of minute arthropods. Proceedings of the Entomologieal Soeiety of Ontario 127: 67-87.

CASSIS, G. 1995. A reelassifieation and phylogeny of the Termatophylini (Heteroptera: Miridae: Deraeoeorinae), with a taxonomie revision of the Australian speeies, and a review of the tribal elassifieation of the Deraeoeorinae. Proeeedings of the Entomologieal Soeiety of Washington 97(2): 258-330.

CASSIS, G. & GROSS, G.F. 1995. Hemiptera: Heteroptera (Coleorrhyneha to Cimieomorpha). Zoologieal Catalogue of Australia. Volume 27.3A. i-xv, 506 pp (CSIRO Publishing: Melbourne).

CASSIS, G., SCHWARTZ, M.D. & MOULDS, T. 2003. Systematics and new taxa of the *Vannius* eomplex (Hemiptera: Miridae: Cylapinae) from the Australian Region. Memoirs of the Queensland Museum 49: 125-143.

DISTANT, W.L. 1920. Rhynehota from New Caledonia. Annals and Magazine of Natural History (9)6:143-164.

DONALDSON, J.F. 1988. Further studies on Asiraeinae (Homoptera: Delphaeidae) in Australia and New Caledonia. Journal of the Australian Entomologieal Soeiety 27:133-141.

EDGECOMBE, G.D. 2003. A new genus of henieopid eentipede (Chilopoda: Lithobiomorpha) from New Caledonia. Memoirs of the Queensland Museum 49(1): 269-284.

EVANS, J.W. 1982. A review of present knowledge of the family Peloridiidae and new genera and new speeies from New Zealand and New Caledonia (Hemiptera: Inseeta). Reeords of the Australian Museum 34: 381-406.

GORCZYCA, J. 2000. A systematie study on Cylapinae with a revision of the Afrotropieal Region (Heteroptera, Miridae). Wydawnictwo Uniwersytetu Slaskiego, Katowiee 2000: 1-174.

HAMILTON, A. 1999. The ground-dwelling leafhoppers Myerslopiidae, new family, and Sagmatiini, new tribe (Homoptera: Membracoidea). Invertebrate Taxonomy 13:207-235.

JAFFRÉ, T., BOUCHET, P.H., VEILLON, J.-M., RIGAULT, F. & DAGOSTINI, G. 2001. Composition and charaeterization of the native flora of New Caledonia. IRD Doeuments Seientifiques et Teehniques (2)4: 1-121.

KERZHNER, I.M. & KONSTANTINOV, F.V. 1999. Strueture of the aedeagus in Miridae (Heteroptera) and its bearing to supragenerie elassifieation. Aeta Soeietas Zoologieae Bohemieae 63: 117-137.

MADDISON, W.P. & MADDISON, W.R. 2001. MacClade 4. Analysis of Phylogeny and Character Evolution. Version 3. Sunderland: Sinauer Assoeiates (Version 4.02).

MITTERMEIER, R.A., GIL, P.R., HOFFMAN, M., PILGRIM, J., BROOKS, T., MITTERMEIER, C.G., LAMOREUX, J. & DA FONSECA, G.A.B. 2004. Hotspots revisited. Washington DC: Cemex.

MONTEITH, G.B. 1980. Relationships of the genera of Chinamyersiinae, with deseription of a reliet speeies from north Queensland (Hemiptera: Heteroptera: Aradidae). Paeifie Inseets 21(4): 275-285.

MONTEITH, G.B., BURWELL, C.J. & WRIGHT, S.G. 2005. Inventaire de l'entomofaune de la forêt humide de quatre réserves spéeiales botaniques du Grand Sud de la Nouvelle Calédonie. Report to Direetion des Ressourees naturelles, Provinee Sud. 136 pp. (Queensland Museum, Brisbane).

RAVEN, P.H. & AXELROD, D.I. 1972. Plate teetonies and Australasian biogeography. Seienee, New York 176: 1379-1386.

SCHUH, R.T. 1975. The strueture, distribution and taxonomie importanee of triehobothria in the Miridae (Hemiptera). Ameriean Museum Novitates 2585: 1-26.

1976. Pretarsal strueture in the Miridae (Hemiptera) with a eladistie analysis of relationships within the family. Ameriean Museum Novitates 2601: 1-39.

1986. *Schizopteromiris*, a new genus and four new species of coleopteroid eylapine Miridae from the Australian Region (Heteroptera). Annales de la Société Entomologique de France (N.S.) 22(2):241-246.

SCHUH, R.T. & SLATER, J.A. 1995. True Bugs of the World (Hemiptera: Heteroptera). Classification and Natural History. i-xii, 336pp (Cornell University Press, Ithaca, New York).

ŠTYS, P. 1981. A new relict subfamily, genus and species of Enieocephalidae from New Caledonia (Heteroptera). Acta Entomologica Bohemoslavaca 78:412-429.

SWEARINGEN, M., HEADRICK, D. & BELLOWS, T. 1997. Comparison of fixation and drying procedures for scanning electron microscopy among insect body types. Proeeedings of the Entomologieal Society of Washington 99(3): 513-522.

SWOFFORD, D.L. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and other methods). Version 4.0b10. (Sinauer Associates: Sunderland).

WHEELER, A.G. 2000. Biology of the Plant Bugs (Hemiptera: Miridae). Pests, Predators, Opportunists. (Cornell University Press: Ithaca).

CHLAMYDOPSINAE (COLEOPTERA: HISTERIDAE) FROM NEW CALEDONIA

MICHAEL S. CATERINO

Caterino, M.S. 2006 11 10: Chlamydopsinae (Histeridae) from New Caledonia. *Memoirs of the Queensland Museum* **52**(1): 27-64 Brisbane. ISSN 0079-8835.

Chlamydopsinae are reported from New Caledonia for the first time. Eighteen species are described in *Chlamydonia* gen. nov. One species is placed in *Kanakopsis* gen. nov. The remaining two species are placed in *Chlamydopsis* Westwood, representing the first records of this genus outside of Australia and New Guinea. A number of characters suggest placement of the two new genera near each other (though not as each other's sister group) at the base of the widespread *Orectoscelis/Eucurtiopsis* group of genera. The *Chlamydopsis* species described here do not belong within any of the previously proposed species groups of this genus. Though no specimens of the new taxa have associated host data, trichomes strongly suggest that they are myrmecophilous, like most other Chlamydopsinae.
❐ *Coleoptera, Histeridae, Chlamydopsinae, myrmecophily, New Caledonia.*

Michael S. Caterino, Santa Barbara Museum of Natural History, 2559 Puesta del Sol Rd, Santa Barbara, CA 93105 USA (email: mcaterino@sbnature2.org). *9 November, 2005.*

The histerid fauna of New Caledonia has received substantial attention relative to most beetles of most Pacific Islands. In addition to discussions of Histeridae in general works (e.g. Fauvel, 1891), a dedicated analysis of the New Caledonian histerid fauna was published by Wenzel (1955), recognising 19 species from the islands. More recently Gomy (1976, 1982) added 10 to this total. Despite this attention, no previous workers have reported the occurrence of Chlamydopsinae from New Caledonia. The Chlamydopsinae is a subfamily of highly specialised histerid beetles, most of which are believed to live in the nests of ants. Recent collections utilising flight intercception traps have produced specimens representing 21 distinctive, and previously undescribed, species.

The new species represent two or three distinct lineages. Two of the species are assigned to the genus *Chlamydopsis* Westwood, previously known only from Australia and New Guinea (Caterino, 2003). These species, while closely related to each other, do not obviously fit into any of the previously recognised species groups, and are clearly quite isolated in the genus. Nonetheless, phylogenetic analyses including one of these species do place it in the genus (Caterino, 2003; Caterino & Dégallier, unpublished data).

Eighteen of the species form a coherent, and apparently monophyletic group very distinct from *Chlamydopsis*. Superficially, several of these species resemble known species of *Orectoscelis* Lewis and *Eucurtiopsis* Silvestri. However, a number of consistent, shared differences from any other known Chlamydopsinae suggest that this similarity is either symplesiomorphy or convergence, and a new genus, *Chlamydonia*, is established here for them. Relationships of this genus to other Chlamydopsinae have been examined (Caterino & Dégallier, unpublished data), where it is resolved tentatively as sister to the *'Orectoscelis* lineage' (including, additionally, *Pheidoliphila* Lea, *Ceratohister* Reichensperger, *Eucurtiopsis*, *Gomyopsis* Dégallier, and a few others currently being described elsewhere). An analysis of relationships among the species of *Chlamydonia* is undertaken below.

Finally, a new genus, *Kanakopsis*, is described for a single species that appears distinct from either of the above groups and from any other known Chlamydopsinae. As above, this species superficially resembles some species of *Eucurtiopsis*. But various structural differences, particularly of the mouthparts, argue against such a relationship. A larger scale analysis of relationships among chlamydopsine genera in progress (Caterino & Dégallier, unpublished data) places this taxon alone as sister to a lineage comprising *Chlamydonia* and the *'Orectoscelis* lineage'.

Nearly all available chlamydopsine specimens from New Caledonia have been collected by flight intercception trapping (conducted by G.B. Monteith and his colleagues from the Queensland Museum). A few additional specimens were found by pyrethrum fogging of trees and logs, and a single one was collected by Berlese extraction of sifted leaf litter. Thus, there is virtually nothing known of the natural history of these beetles. It is probably a safe assumption that they are myrmecophilous, as are essentially all

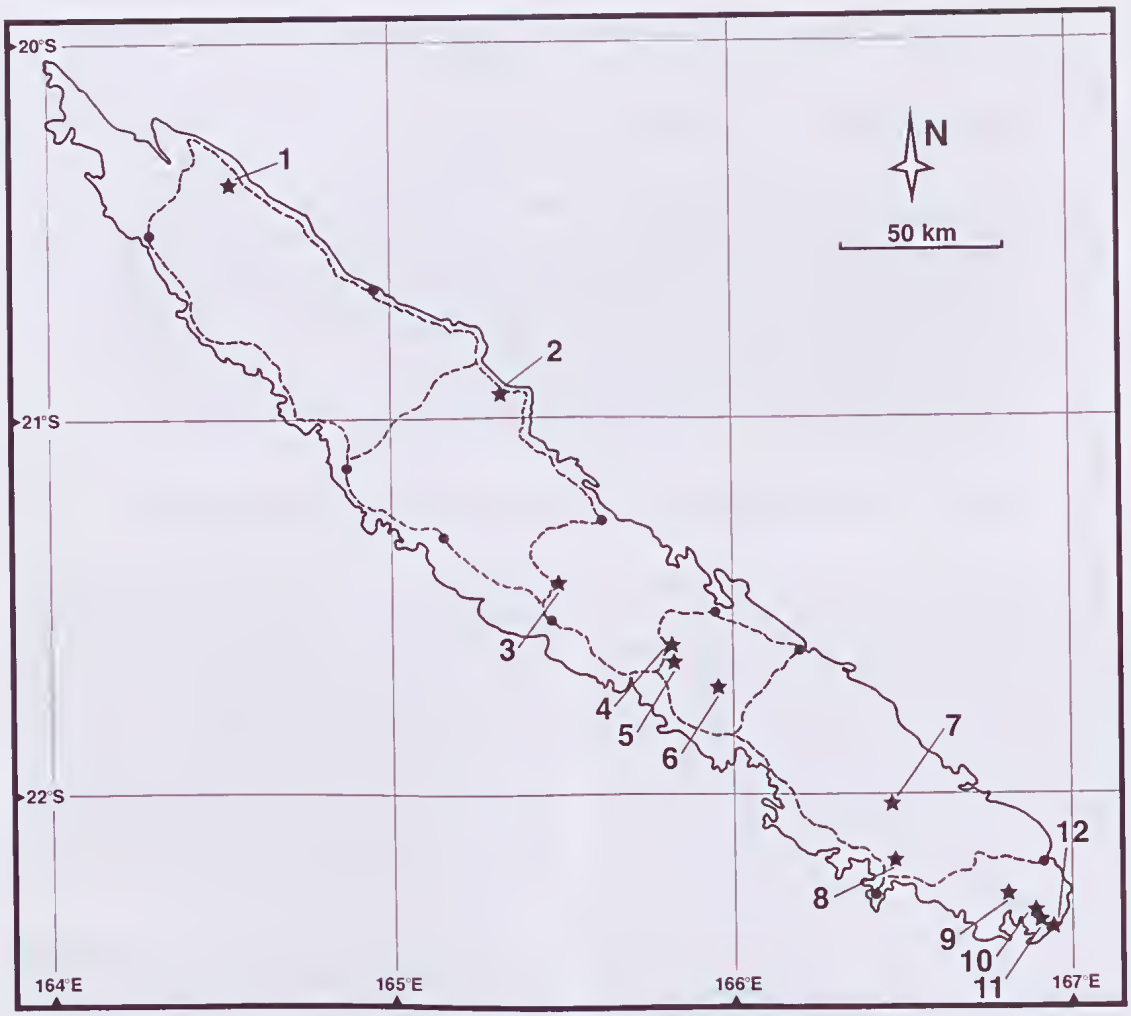


FIG. 1. Map of New Caledonia showing all localities discussed in this paper, numbered as follows: 1. Mandjèlia summit; 2. Pic d'Amoa, north slopes; 3. Col des Roussettes; 4. Col d'Amieu (sawmill); 5. Col d'Amieu (west slope); 6. Mt Do summit; 7. Mt Dzumac Road; 8. Mt Koghis; 9. Pic du Pin (east base); 10. Pic du Grand Kaori; 11. Kwa Ncie (Foret Nord) summit; 12. Port Boisé.

Chlamydopsinae whose habits are known, both for phylogenetic reasons, and because all possess conspicuous trichomes, almost invariably indicative of myrmecophily. The ant fauna of New Caledonia is reasonably well known, with about 40 genera reported from the country (though several of these are represented only by introduced species; Taylor, 1987). Of those considered native, top contenders as possible hosts are *Rhytidoponera* Mayr and *Pheidole* Westwood, with 18 and 5 probable native (described) species in New Caledonia, respectively. These are the predominant hosts of Chlamydopsinae in Australia. However, the ant genera *Camponotus* Mayr, *Dolichoderus* Lund, *Iridomyrmex* Mayr, and *Meranoplus* Smith all have native New Caledonian species and have been reported hosts of Australian Chlamydopsinae, as well. It is also worth noting that all specimens taken by Queensland Museum collectors have also been found in rainforest areas, rather than in the drier, 'maquis' vegetation areas.

METHODS

A number of body dimensions and proportions are useful for species recognition. Following histerid conventions, total body length (L) is measured from the anterior margin of the pronotum to the posterior margin of the elytra, while width

(W) is taken at the widest point, invariably near the elytral humeri. Measurements were made of the holotype where possible, are grouped at the beginning of each description (or diagnosis if no description is presented) to facilitate comparisons, and are abbreviated as follows: L (mm – dorsal length along midline); W (mm – width across humeri); E/PnL (ratio – elytral length/pronotal length); E/PnW (ratio – elytral width/pronotal width); Pn W/L (ratio – pronotum width/length); E L/W (ratio – elytra length/width); Pr/Py (ratio – propygidium length/pygidium length); Sterna – pro,meso,meta (mm – lengths along midline); Tibiae – pro, meso,meta (mm - straight line length from base to apex, ignoring curvature).

Many of the newly described species share type localities. All localities mentioned below are mapped in Figure 1. Colour versions of the photographs can be viewed online at: http://www.sbnature.org/collections/invert/entom/chlamydopsinae/Caterino2006/Caterino2006suppl.htm. Repositories are abbreviated as follows: MNHN: Muséum National d'Histoire Naturelle, Paris; QM: Queensland Museum, Brisbane; CMN: Canadian Museum of Nature, Ottawa; MHNG: Muséum d'Histoire Naturelle, Geneva; MSCC: Michael S. Caterino Collection, Santa Barbara; HNHM: Hungarian Natural History Museum, Budapest. Boldface four and five digit numbers cited with label data for Queensland Museum specimens correspond to that institution's "Sampcodes", sequential lot numbers that link specimens to collections data in the Museum's database.

KEY TO THE CHLAMYDOPSINAE OF NEW CALEDONIA

1. Scutellum small but easily visible, upper surface flush with elytral surface (Fig. 2A); prosternum short, carina-delimited leg depression occupying most of lateral area of prosternum, its anterior margin nearly reaching anterior prosternal margin (separated by less than a tarsus width) in the anterolateral corner (*Chlamydopsis*) 2

   Scutellum minute, reduced, and though generally visible between bases of elytra, never flush with elytral surface (Fig. 2B); prosternum longer, anterolateral corner of proleg depression separated from anterior prosternal margin by at least three tarsal widths (Fig. 8D).....3

2. Elevated lateral margins of pronotum with conspicuous setal fringe; elytra coarsely reticulostrigose, shining (Fig. 3A)..... *Chlamydopsis caledoniae* sp. nov.

   Elevated lateral margins of pronotum without setal fringe; elytra finely reticulostrigose, densely microsculptured, alutaceous, only shining within mediobasal depression (Fig. 3B) ..... *Chlamydopsis baloghi* sp. nov.

3. Body smooth, entirely impunctate (Fig. 7A, B); frons flat, lacking tubercles; epipleuron with a single marginal stria which departs from margin above metathoracic leg; pronotum strongly convex; trichome consisting of a fairly simple, transverse, setose incision ..... *Kanakopsis amieuensis* sp. nov.

   Body with at least pronotum conspicuously, usually very densely, punctate; frons with at least one pair of prominent tubercles, usually 2-3 pairs (Fig. 8A); epipleuron with accessory marginal stria, such that one stria closely follows margin above metathoracic leg and one departs describing its upper arc of motion (Fig. 8B); convexity of pronotum varied; trichome usually consisting of an elongate, variously sinuate setose elevation .....(*Chlamydonia*) 4

4. Elytra almost entirely impunctate, with at most a few inconspicuous punctures near scutellar region and uppermost edge of trichome (Figs 18, 20) 5

   Elytra densely punctate, in some with small impunctate area within mediobasal depression 8

5. Setal fringe of trichome erect, extremely elongate (Figs 18A, 19A) ..... *Chlamydonia erectipilosa* sp. nov.

   Setal fringe of trichome short, at most suberect, directed mesad (Figs 18B, 19B, 20, 21) 6

6. Uppermost surface of trichome disc impunctate, bearing particularly dense fringe; trichome disc reduced in size, with corresponding enlargement of posterior basal trichome incision, in lateral view posterior opening accounts for as much of elytral length as adjacent 'trunk' of trichome disc (Fig. 21B) ..... *Chlamydonia fauveli* sp. nov.

   Uppermost surface of trichome disc with at least a few obvious punctures near its upper edge; trichome fringe less dense; 'trunk' of lateral surface of trichome disc wider than opening of posterior basal incision behind it (e.g., Figs 19B, 21A) 7

7. Elytra nearly twice as wide as base of pronotum (ratio of elytral to pronotum width ~1.9); trichome extending just behind elytral midpoint (Fig. 18B) ..... *Chlamydonia eucurtiopsoides* sp. nov.

   Elytra relatively narrower (ratio of elytral to pronotum width ~1.7); trichome ending in front of elytral midpoint (Fig. 20A) ..... *Chlamydonia punctinota* sp. nov.

8. Trichome with erect, very elongate setal fringe (Figs 16B, 17B, 26B, 27B) 9

   Trichome with short, suberect or horizontally directed setal fringe 10

9. Setal fringe of trichome confined to basal half of elytron, occurring only along arc of trichome disc (Fig. 16B); sides of pronotum convex, laterally rounded ..... *Chlamydonia stellata* sp. nov.

   Setal fringe of trichome extending from posterior half of small trichome disc posterad along elevated carina to apical one-fourth of elytron (Fig. 26B); sides of pronotum subdepressed, weakly margined along anterior half ..... *Chlamydonia wenzeli* sp. nov.

10. Setal fringe of trichome originating at humeral corner of elytron, extending posterad without interruption along inner edge of trichome disc (Figs 10, 12, 14, 16A, 22A) 11

    Main part of setal fringe of trichome originating distinctly posterad of humeral corner (in most with inconspicuous separate cluster of setae in the anterior corner), restricted to a mesally directed angulate carina about one-third of the way back on elytron (Figs 22B, 24, 26A) 18

11. Trichome with an inwardly directed setal fringe, borne on a carina originating at humeral corner, extending posterad weakly arcuately to about one-third from base, then bending obliquely mesad (Fig.22A); epipleuron with two distinct pits below posterior angulation of trichome (Figs 23A, 28D) ..... *Chlamydonia terapoides* sp. nov.

Trichome with setal fringe borne on a distinctly arcuate elevated disc, which is incised to epipleuron at its anterior and posterior bases (Figs 11, 13, 15, 17A); if a short carina extends posteromesad from inner corner of trichome it is glabrous; epipleuron lacking pits beneath trichome (Fig. 8B) 12

12. Mesal surface of trichome elevation (beneath setal fringe) lacking median fovea, surface convex, solid (Fig. 28A) 13

Mesal surface of trichome elevation with distinct, deep median fovea, generally beneath midpoint of setal fringe, continuous with floor of mediobasal elytral depression (Figs 28B, *C*) 14

13. Elevated disc of trichome larger, width of narrowest part of 'trunk' greater than that of trichome fringe filling posterior incision behind it (as measured longitudinally along epipleuron; Fig. 15B); less densely punctate, with punctures of posterior part of pronotum separated by nearly their widths, with smooth intervening integument ..... *Chlamydonia inflata* sp. nov.

Elevated disc of trichome smaller, width of the narrowest part of trunk less than that of greatest width of setose area behind it (Fig. 17A); more densely punctate throughout, with posterior part of pronotum deeply and contiguously punctate ... *Chlamydonia densa* sp. nov.

14. Anterior basal incision of trichome with setal fringe interrupted by a triangular humeral projection, isolating a small, circular humeral whorl from inner fringe (Fig. 12A); convexity of outer surface of trichome disc uneven, its epipleural surface convex, becoming weakly depressed dorsad of a poorly defined lateral ridge; texture microgranulate below, and with large deep punctures above this ridge ..... *Chlamydonia gomyi* sp. nov.

Setal fringe of anterior basal incision of trichome not interrupted by basal constriction, continuous; trichome disc varied 15

15. Setal fringe of trichome moderately elongate, inwardly directed basally, but with apices curving upward and posterad along its entire length, appearing 'unkempt' (Fig. 15A) ..... *Chlamydonia foveata* sp. nov.

Setal fringe of trichome short, all setae directed inwardly to suberect, with apices neat and even 16

16. Trichome elongate, extending fully two-thirds the length of elytron (Fig. 12B) .. *Chlamydonia tjibaoui* sp. nov.

Trichome shorter, extending to or just slightly beyond elytral midpoint (Fig. 10) 17

17. Trichome disc inclined inward at about 45° (in anterior view) ..... *Chlamydonia costata* sp. nov.

Trichome disc more nearly vertical, inclined about 30° off vertical ..... *Chlamydonia sol* sp. nov.

18. Meso- and metatibiae strongly expanded, flattened, outer margin of metatibia in particular, almost evenly rounded, not even bluntly angulate; setose part of trichome evenly rounded, not outwardly angulate (Fig. 22B), its outer edge elevated .... *Chlamydonia sinuata* sp. nov.

Meso- and metatibiae not broadly expanded, their outer margins bluntly to acutely angulate; setose part of trichome angulate (Figs 24, 26A), outermost edge usually lower than inner edges 19

19. Epipleuron uniformly, moderately densely punctate (only slightly less densely than dorsum), including within accessory stria; setose angulation of trichome relatively shallow, anterior and posterior edges meeting at an obtuse angle (about 120°; Fig. 24A) ..... *Chlamydonia dzumacensis* sp. nov.

Epipleuron not densely punctate, distinctly less so than dorsum, and area within accessory stria with at most fine sparse punctures; setose angulation of trichome deeper, anterior and posterior edges meeting at approximately 90° (or slightly less; Figs 24B, 25A) 20

20. Epipleuron with deep vertical groove adjacent to apex of inner setose angulation, forming a distinct constriction between anterior trichome disc and posterior elevation (Fig. 27A); posteromedian corner of trichome extended by distinct oblique carina for a distance approximately equal to length of setose portion of trichome; body with rather dense, but short setae throughout ..... *Chlamydania angulata* sp. nov.

Epipleuron with at most very superficial vertical groove outside setose angulation, not appearing thus constricted; posteromedian elytral carina shorter than setose area before it; body setae longer but sparser ..... *Chlamydonia volans* sp. nov.

Chlamydopsis caledoniae sp. nov.
(Figs 2A, 3A, 4A, 5A, 5C-F)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 8910, 22°21'Sx166°58'E, Port Boise (G.Kanua), 22 Nov 2001-29 Jan 2002, G.B. Monteith, FIT trap; in MNHN. PARATYPES: 1 ♀; same data as holotype; in QM.

DIAGNOSIS. This species and the following are easily distinguished from other Chlamydopsinae known from New Caledonia by the fully exposed scutellum, relatively small rounded humeral trichomes, short prosternum, and peculiarly thickened protibiae. These two *Chlamydopsis* are similar in basic morphology, but differ markedly in superficial characters. In particular the elevated lateral pronotal margins of *C. caledoniae* bear a dense setal fringe completely absent from *C. baloghi*. The pronotum of *C. caledoniae* is also shorter, more transverse. The reticulations of most body surfaces particularly the elytral discs, are distinctly less dense in *C. caledoniae*, with the ground texture smooth and shining, while that of *C. baloghi* is microsculptured and dull. Most of the surface of *C. caledoniae* bears sparse but conspicuous flattened setae; the body of *C. baloghi* bears only minute fine setae (apart from fringe of trichome.) Additionally, at least in the Type specimens, these differ somewhat in color, with *C. caledoniae* much darker, near black, whereas *C. baloghi* is distinctly rufescent (and not obviously teneral).

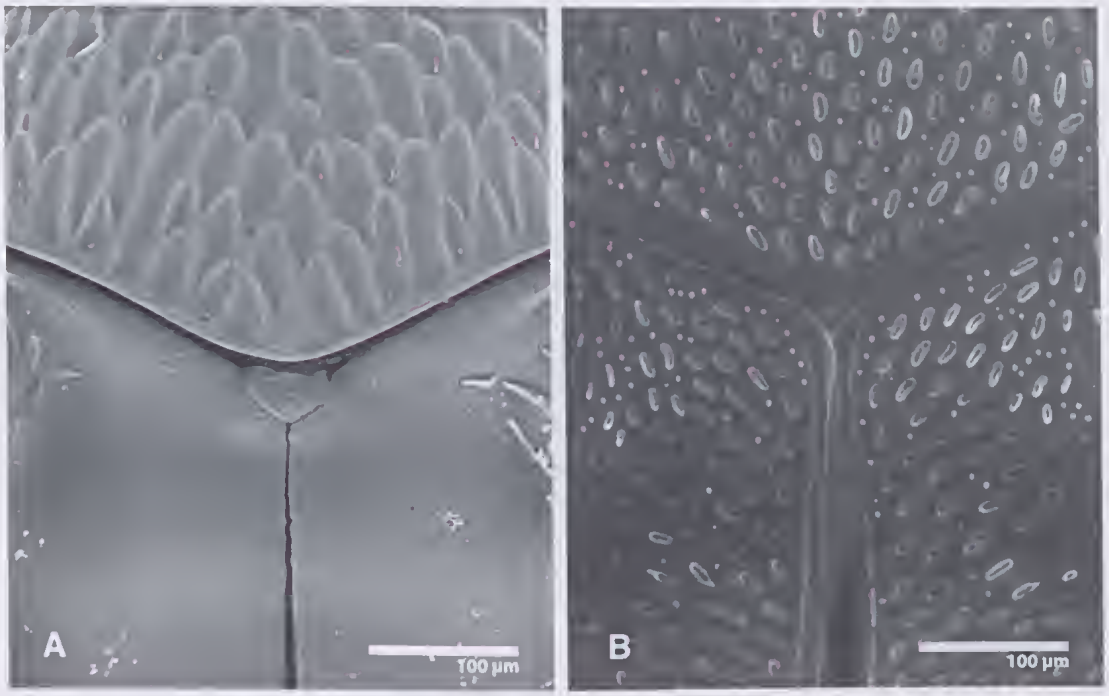


FIG. 2. Scutellum. A, *Chlamydopsis caledoniae* sp. nov.; B, *Chlamydonia* sp.

DESCRIPTION. L: 1.75; W: 1.22; E/Pn L: 1.95; E/Pn W: 1.26; Pn W/L: 1.63; E L/W: 0.95; Pr/Py: 0.77; Sterna: 0.47, 0.08, 0.47; Tibiae: 0.69, 0.69, 0.78. Body quadrate, dark, slightly rufescent brown, shining; most dorsal surfaces reticulostrigose, sparsely setose, setae faintly scalelike. Front of head, when retracted slightly proclinate; frons with sides weakly rounded, about 1.3x as long as wide, reticulately punctured, with sparse scale-like setae, especially near vertex; labrum about 2.2x as wide as long, anterior margin weakly rounded, disc shallowly reticulopunctate; antennal scape 2x as long as wide, widest near middle, disc very faintly reticulate, with scale-like setae, especially along outer margin; antennal club of female about one-third, that of male about two-thirds, scape length.

Sides of pronotum approximately parallel in basal half, converging apically to one-half basal width; lateral pronotal margin slightly elevated, bearing dense fringe of short, scale-like setae (these absent from anterior margin); lateral and anterior pronotal margins with continuous, fine, deep groove just inside margin, anterior portion of pronotal disc elevated slightly behind this groove; pronotal disc moderately convex medially, flattened slightly towards sides, entirely reticulostrigose, more elongately so posterolaterally. Antennal cavities broadly exposed from above. Prosternum short, its anterior margin broadly, deeply emarginate, with fine marginal stria; prosternal keel sharply rising anteriorly (reducing prosternal 'depth' anteriorly), narrowed between procoxae, emarginate posteriorly, bordered laterally by finely, but deeply impressed circumcoxal stria; prosternal disc entirely reticulostrigose.

Elytra with prominent humeral trichomes confined to basal one-third, with single broad, more or less flat, setose anterior elevation bearing anterior superficial stria along its outer edge, with a deep round fovea near inner apex; inner edges of anterior and posterior trichome elevations meeting near their apices, both with dense, golden setal fringe beneath meeting point; opening of trichome lateral to these inner edges small, rounded with small additional tuft of inwardly directed setae near outer edge; epipleuron separated from elytral dorsum by finely impressed stria extending from posterolateral corner anteriorly, curving into opening of trichome; most of elytral dorsum, and anterior one-third of epipleuron, reticulostrigose and sparsely setose, with reticulae more elongate across middle third of elytral dorsum; mediobasal

depression and posterior two-thirds of epipleuron impunctate and glabrous.

Mesosternum wide, projecting at middle, and extending forward around inner edge of mesocoxa; marginal stria obsolete at middle, visible mainly as oblique lateral fragments well mesal of mesocoxa; disc with small shallow punctures, conspicuously microsculptured between; mesometasternal and median metasternal striae finely but deeply impressed; metasternal disc impunctate, smooth, with only minute setae medially, with a few small punctures at sides and within mesotibial depressions; 1st abdominal ventrite with postcoxal stria deeply impressed, continuous across middle.

Femora slightly widened apically, outer surface of profemur with few punctures near base, otherwise exposed surfaces of all femora impunctate, with very fine polygonal microsculpture (becoming inconspicuous at their apices) and fine sparse setae; protibia broadly rounded, somewhat thickened just beyond middle, tarsal groove expanded, with unique fovea near its midpoint (about one-third from apex of tibia), outer margin sinuous; posterior surface of protibia sparsely setose, lacking microsculpture; posterior tibiae with outer edges rounded, mesotibia widest near middle, metatibia widest about two-thirds from base, both with fine polygonal microsculpture on outer surfaces.

Propygidium and pygidium both weakly convex, both reticulopunctate, pygidium becoming smooth in apical half.

Male. Eighth abdominal tergite largely membranous, extending to about two thirds length of ventral portions of segment 8; ninth segment very reduced, dorsolateral components separate, linear, abruptly broadened at bases, curving inward at apices; spiculum gastrale short, subquadrate, weakly expanded at apex, desclerotised at middle; tergite 10 completely desclerotised, not visible; aedeagus rather short, only about one-third longer than genital capsule (segments 8-10), basal piece almost one-third length of tegmen; tegmen slightly narrower than basal piece, narrowed from base to apex, weakly and evenly curving ventrad toward apex; apices of tegmen slightly separated, this apical cleft enlarged around tip of median lobe; median lobe nearly as long as tegmen, with fine, weak proximal apodemes.

Female. Ovipositor with valvifer paddle-shaped, basal expanded portion nearly half of entire valvifer length; coxite short, nearly as wide at base as maximum length, about half as long as valvifer, with two well developed apical teeth; gonostyle present on upper surface between bases of apical teeth, bearing two elongate and several short setae at its apex.

REMARKS. This species is mentioned, and included in the phylogenetic analysis, in Caterino's (2003) review of *Chlamydopsis* While quite distinctive, and not assignable to any of the species groups established in that paper, this species does resolve within *Chlamydopsis*, and its position there seems well founded.

Chlamydopsis baloghi sp. nov.
(Figs 3B, 4B, 5B)

MATERIAL. HOLOTYPE ♀: NEW-CALEDONIA, Bourail, Col d.Rousettes /26-27.1.1977, leg. Dr J. BALOGH; in HNHM.

DIAGNOSIS. See above under *C. caledoniae*.

DESCRIPTION. (to the extent that it differs from *C. caledoniae*). L: 1.95; W: 1.31; E/Pn L: 1.98; E/Pn W: 1.24; Pn W/L: 1.62; E L/W: 0.99; Pr/Py: 0.72; Sterna: 0.50, 0.09, 0.56; Tibiae: 0.87, 0.84, 0.94. Body quadrate, slightly elongate relative to *C. caledoniae*, dark rufescent, most surfaces densely reticulostrigose, with ground texture (between elevated reticulae) of dense polygonal microsculpture; apart from fringe of humeral trichome, body with only minute fine setae. Frons densely reticulate, with dense ground sculpture; antennal scape lacking reticulations, with only dense polygonal microsculpture. Pronotum with basal half of lateral margins subparallel, weakly outwardly arcuate, narrowed at approximately 45° to narrow, weakly emarginate, anterior margin; pronotal sides elevated (moreso than *C. caledoniae*), the anterior slightly less so, with distinct continuous groove just beneath inner edge, this groove becoming deeper anteriorly such that anterior portion of pronotal disc projects slightly higher than margin in front of groove; most of pronotal disc densely reticulate, reticulae very weakly elongate, particularly anteriorly and laterally, with dense microsculpture between, inner surfaces of the elevated sides smooth, shining. Elytra and humeral trichome structurally as in *C. caledoniae*; disc of elytron behind trichome densely reticulostrigose, with reticulae narrowed and elongated, particularly so in sutural half; ground texture within even narrow reticulae densely microsculptured; epipleural disc reticulate

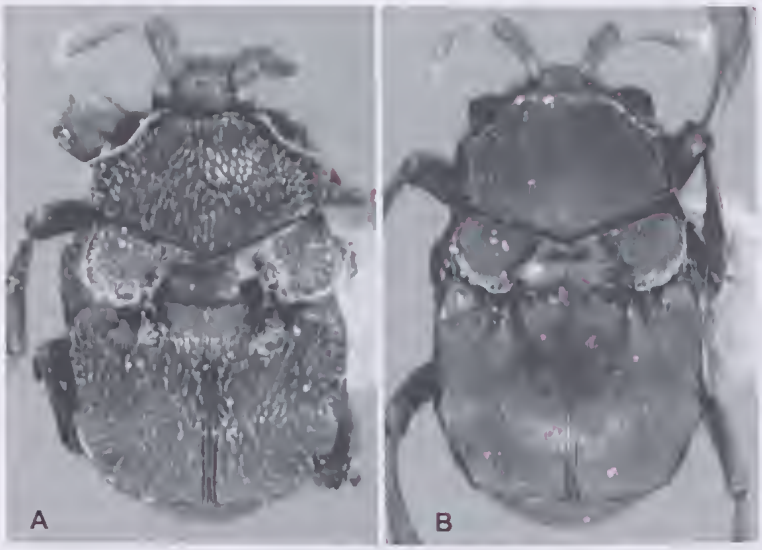


FIG. 3. Dorsal photographs of *Chlamydopsis* spp. A, *C. caledoniae* sp. nov.; B, *C. baloghi* sp. nov.

in basal half, becoming less deeply so posteriorly. Mesosternum with short oblique striae as in *C. caledoniae*, but more deeply incised. Protibiae apically enlarged as in *C. caledoniae*, but more distinctly sinuate, particularly along inner edge, with fovea of tarsal groove located about one-fifth from apex; meso- and metatibiae with outer edges rounded. Propygidium and basal half of pygidium densely reticulate, with dense ground microsculpture; propygidium with broad shallow depression on either side of midline in basal half; pygidium with shallow depressions along outer edges in apical two-thirds.

REMARKS. This species is named for its collector, acarologist János Balogh.

Kanakopsis gen. nov.

TYPE SPECIES. *Kanakopsis amieuensis* Caterino sp. nov.

DIAGNOSIS. This highly distinctive chlamydopsine resembles some species of the *Orectoscelis* lineage (also including *Pheidoliphila*, *Ceratohister*, and *Eucurtiopsis*), and was initially thought to belong within that group, possibly as a *Eucurtiopsis*. However, several differences distinguish it from any of those genera. They are all united primarily by a completely hidden scutellum, as well as by several simplifications of the mouthparts, including the fusion of the mentum and prementum into a bifid, cylindrical tube bearing 2-segmented palpi. *Kanakopsis* instead has mouthparts like *Chlamydonia*, with a distinct prementum, and 3-segmented labial palpi (Fig. 6). It also apparently has a scutellum that would be visible in a clean specimen (I have not been able to absolutely confirm this without damaging the unique type), but it is less evident than is the case in any *Chlamydonia*. It lacks two features common to all *Chlamydonia*: an accessory epipleural stria, and any hints of either frontal or anterior pronotal processes. To cite a positive feature unique to this genus, the trichome, comprising a simple transverse rounded incision near the humeral elytral corner (Fig. 7A), is very distinct from any other New Caledonian Chlamydopsinae (though reminiscent of some extralimital *Eucurtiopsis*.) Beyond these characters it is hoped that

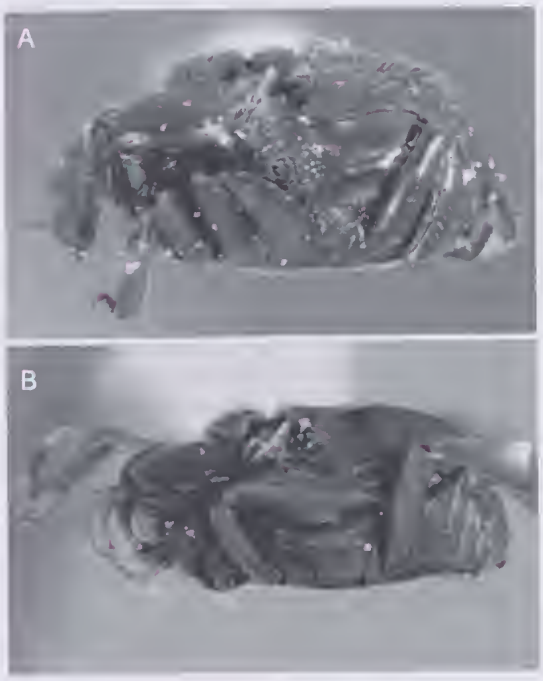


FIG. 4. Lateral photographs of *Chlamydopsis* spp. A, *C. caledoniae* sp. nov.; B, *C. baloghi* sp. nov.

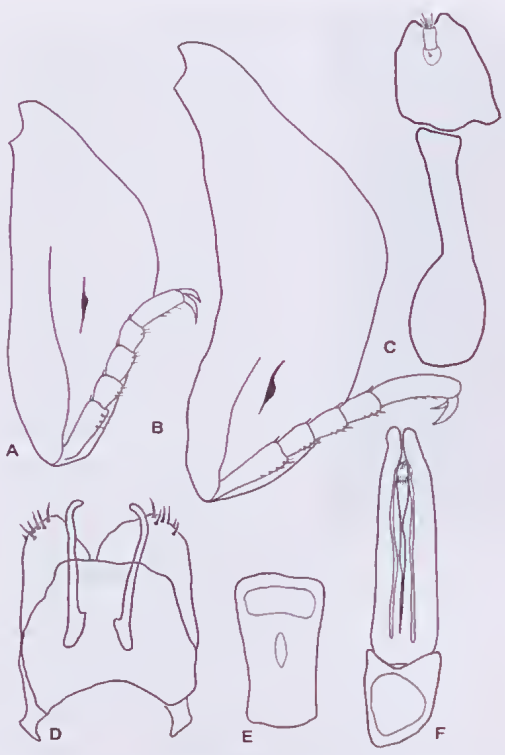


FIG. 5. *Chlamydopsis* spp. nov. A, Protibia of *C. caledoniae*. B, Protibia of *C. baloghi*. C, Right valvifer and coxite of ovipositor of *C. caledoniae*. D, Eighth and ninth segments of male genital capsule of *C. caledoniae*. E, Male spiculum gastrale of *C. caledoniae*. F, Aedeagus of *C. caledoniae*.

discovery of additional material (potentially additional species) will permit a more detailed characterisation of the taxon.

REMARKS. While I am hesitant to establish another monotypic genus of Chlamydopsinae, this species cannot be placed in any existing genus. The prefix Kanak comes from the name of New Caledonia's native people, who also sometimes refer to their homeland as Kanaky.

Kanakopsis amieuensis sp. nov.
(Figs 6, 7A, 7B, 7C)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 11476, 21°35'S × 165°48'E, 400m. Col d'Amieu, sawmill. 25 Nov 2003 - 27 Jan 2004, G.B. Monteith, flight int. trap.; in MNHN.

DESCRIPTION. L: 1.92; W: 1.34; E/Pn L: 1.73; E/Pn W: 1.34; Pn W/L: 1.42; E L/W: 0.91; Pr/Py: 0.92; Sterna: 0.53, 0.09, 0.48; Tibiae: 0.50, 0.47, 0.50. Body oblong, ovoid, pronotum abruptly narrower than elytra, dark rufescent, elytra slightly lighter, smooth and shining, completely impunctate, with sparse, extremely fine setae on most surfaces. Frons with sides rounded, widest just above middle, emarginate at antennal bases, with disc perfectly flat in anterior two-thirds, depressed between faintly protuberant antennal bases; epistomal suture weakly inwardly arcuate; labrum slightly convex, bearing numerous fine setae near apex, with outer margin evenly rounded; mandibles bulbous at base, abruptly narrowed to fine overlapping apices, bearing fine setae on basal anterior surfaces; antennal scape subtriangular, bluntly angulate, widest at middle, with inner edge weakly inwardly arcuate and dorsobasal edge sinuate; antennal funicle about two-thirds as long as scape, approximate ratio of antennomeres 2-8, 4:3:1:1:1:1:1, antennomere 8 only with crown of setae; antennal club (of male) subequal in length to scape, densely pubescent; gular suture divided at base of submentum, resulting sutures weakly impressed (dissection would be necessary to determine whether they are complete); submentum projecting anteriorly between maxillary cardines; mentum irregularly hexagonal, with basal and distal edges longer; prementum projecting slightly beyond apex of mentum, bearing 3 segmented palpi; basal palpomere extremely short, palpomeres 2 and 3 longer, subequal, the ultimate bearing a few short apical setae; cardo deflexed, projecting slightly beneath level of mentum; stipes triangular; maxillary palpi 3 segmented; ratio of lengths of palpomeres 1-3, 2:1:3, ultimate palpomere with a few apical setae.

Prothorax strongly and evenly convex dorsally, with sides arcuate, convergent anteriorly, completely unmargined (entire prothorax oval in cross section); anterior pronotal margin evenly arcuate above head, interrupted at antennal cavity, with complete marginal stria continuous with sternopleural stria laterally; prosternal disc smooth and shining, lacking any processes, entirely convex except weakly depressed in small area in front of scutellum, with basal marginal stria meeting sternopleural stria at sides, complete except briefly interrupted in front of scutellum. Scutellum not evident dorsally, but anterior corners of elytra not completely closing scutellar gap; elytra strongly convex in posterior three-fourths, depressed between humeral trichomes; humeral trichomes present, close to anterolateral corners,

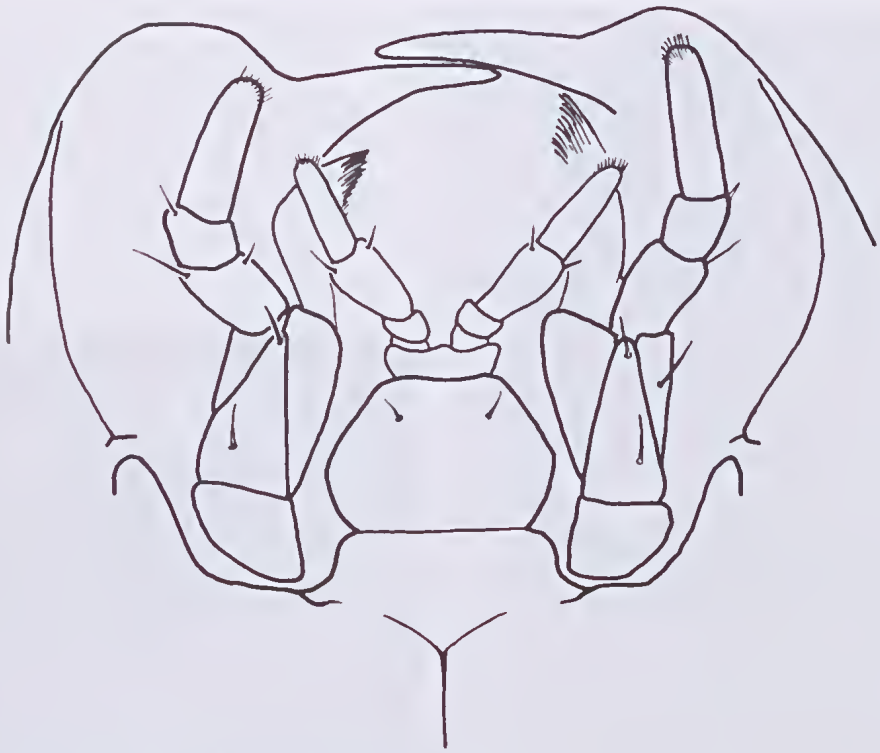


FIG. 6. Ventral view of mouthparts of *Kanakopsis amieuensis* sp. nov.

consisting of a fairly simple transversely oval opening between latero-clinate anterior and posterior elevations, bearing continuous dense inwardly directed marginal fringe in addition to sparser, more nearly erect secondary series of marginal setae, these latter more conspicuous anteriorly than posteriorly; mediobasal elytral depression evenly transversely concave, without median carinae, with sparse setae becoming slightly more numerous near trichome; elytra with prominent short longitudinal carina at apex of posterior convexity, carina forming a slightly projecting, near right angle between dorsal and lateral surfaces, its ridge with series of inconspicuous posteriorly directed appressed setae; epipleuron with oblique depression directed posterad from beneath trichome, otherwise flat to weakly convex, with single marginal stria departing from margin slightly above mesofemur, and more distinctly describing upper arc of metafemur; marginal elytral stria complete around all edges, though only weakly impressed in mediobasal depression.

Median prosternal length approximately two-thirds width (measured between sternopleural sutures), apical margin sinuate, with complete, shallowly impressed marginal stria; prosternal keel approximately parallel-sided between procoxae, but with marginal striae converging to posterior apex, meeting in a narrow arc; apex of keel weakly emarginate. Mesosternal median length about one-fifth its width (measured along mesometasternal suture), weakly projecting anteriorly, with marginal stria an even shallow arc between meso-coxae, approaching anterior mesosternal margin only at middle; meso-metasternal and median metasternal sutures complete, weakly impressed, without coincident striae; post- mesocoxal stria originating behind inner corner of coxa, directed posteriorly for about one-fifth metasternal length, then curving laterad, recurving obliquely anterad, crossing metepisternum to meet epipleuron; metasternal disc smooth and shining, with sparse fine setae.

Profemur with edges weakly arcuate, but more or less parallel, with marginal stria along posterodorsal edge, but not posteroventral; meso- and especially metafemora with edges more strongly rounded, lacking marginal striae; protibia slender, with outer edge angulate about one-third from base; meso- and metatibiae more

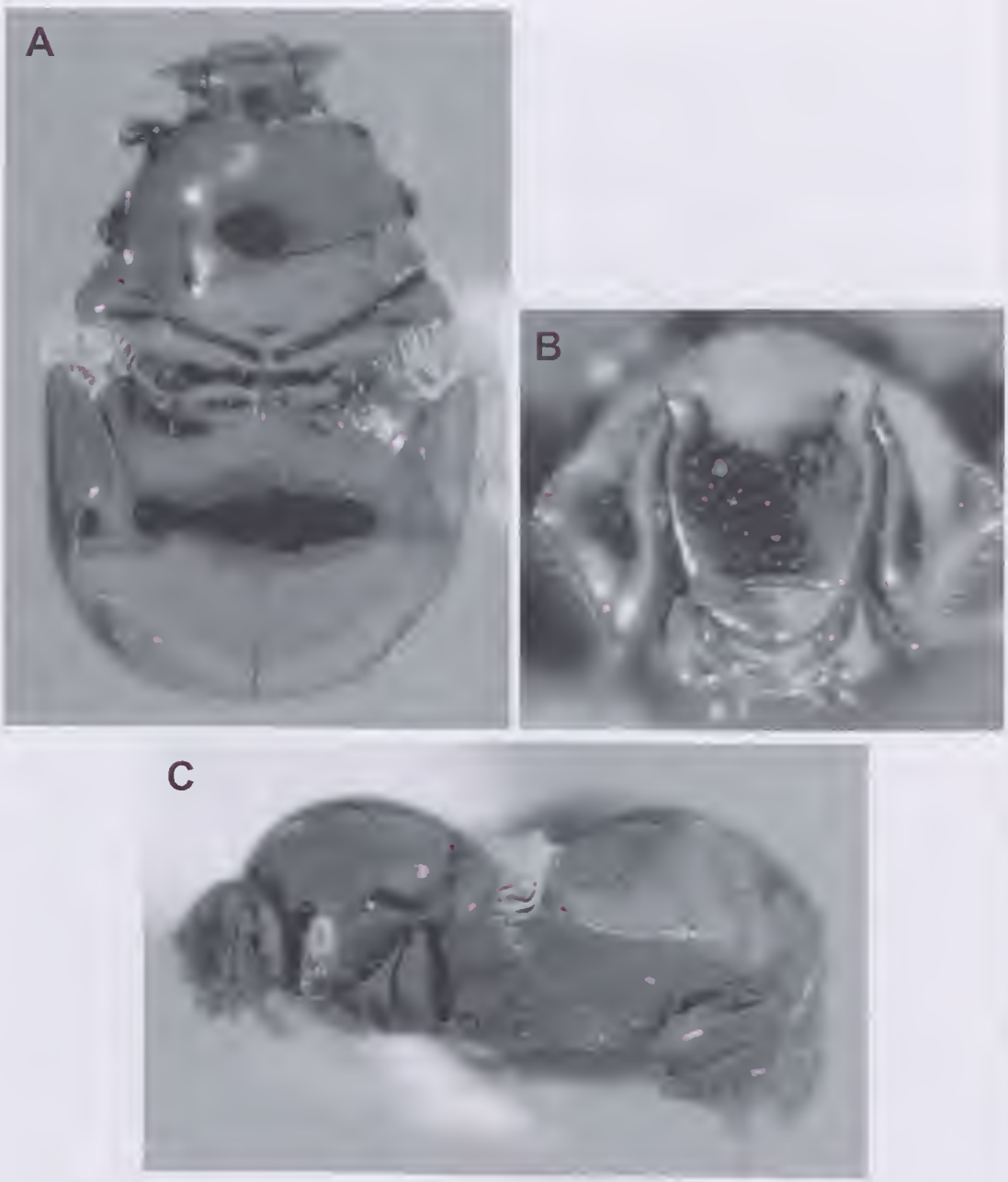


FIG. 7. *Kanakopsis amieuensis* sp. nov. A, Dorsal habitus. B, Frontal view. C, Lateral habitus.

broadly rounded, widest nearer midpoint; tarsi laterally compressed, with elongate ventral setae along length of tarsomere one, and at apices of tarsomeres 2-4; pretarsal claws simple and separate.

Propygidium about two-thirds length of pygidium along midline, both evenly convex, both unmargined, with sparse inconspicuous setae, those of pygidium becoming longer and more conspicuous toward apex.

Genitalia not examined in the unique type.

Chlamydonia gen. nov.

TYPE SPECIES. *Chlamydonia sol* Caterino.

DIAGNOSIS. The species placed here appear quite diverse in form, although this is more superficial than it at first appears. There is substantial variation in elytral sculpturing, and in elaboration of the humeral trichomes, but there are many more structural similarities, and the variation in trichome structure, in particular, constitutes a more or less continuous series. The most conspicuous shared characters are: frons tuberculate in two parallel, longitudinal series (Fig. 8A); median and lateral paired protuberances at the anterior pronotal margin, these ranging from very small to conspicuous and extending back to the pronotal midpoint, the median pair much reduced in some species; epipleural marginal stria doubled above the metathoracic leg (Fig. 8B), with one stria close to and more or less parallel to the lateral elytral margin, and another (termed the accessory epipleural stria below) arched dorsally, its apex usually 2-4x as distant from margin as marginal stria, meeting the marginal stria at the posterolateral corner and near or slightly anterior to the epipleural midpoint, epipleuron less densely punctate between striae; humeral trichomes varied, but more or less elongate in orientation.

DESCRIPTION. In addition to the defining characters above, the genus *Chlamydonia* is described as follows: Body subquadrate, parallel sided to having the elytra substantially broader than prothorax; rufescent to black, frequently with bronzy metallic tinge; most species densely punctate throughout, though a few with elytra and other parts impunctate; glabrous to sparsely setose, never densely setose; frons with tubercles, sides arcuate, abruptly interrupted, angulate at insertion of antennal scape; labrum rounded to subtriangular; mandibles with bases textured as labrum, apices overlapping, abruptly reduced in size, glabrous; venter of head (Fig. 8C) with stem of median gular suture ending free, or extended anterolaterad by short postsubmental sutures (or corresponding weak depressions); posterior edge of oral cavity straight, bases of mentum and cardines adjacent; mentum flat, transverse, rounded to minutely emarginate at apex; ligula distinct; labial palpi 3- segmented, with basal palpomere very short, not completely encircling shaft of palpus, palpomeres 2 and 3 longer, subequal in length; maxilla with 3 segmented palpus, the basal 2 palpomeres short, subequal, the apical about two-thirds as wide, and twice as long as basal segments; antennal scape (Fig. 8A) generally subtriangular, curved at base, bluntly angulate along outer margin; antennal funicle with pedicel and antennomere 3 subequal in length, the latter much narrower (at least at base), antennomeres 4-8 very short; antennal club of female about two-thirds length of scape, that of male from equal in length to 1.5x its length, densely pubescent, most with specialised sensory area near apex of anterior surface.

Prothorax slightly to strongly transverse (ratio width: length 1.3-1.8), moderately to extremely densely punctate, always with oblique carinae ('alae') above inner edge of antennal cavity, and usually with additional pair short parallel carinae near middle of anterior pronotal margin, these occasionally reduced to mere tubercles or absent; pronotum usually rounded laterally, rarely with weak marginal ridge, but never completely margined; prosternum moderately elongate, anterior margin moderately sinuate, with fine marginal stria restricted to extreme margin (not curving posteriorly as in some *Chlamydopsis*) occasionally obsolete at middle; prosternal disc sometimes depressed behind anterior margin, keel narrowed posteriorly (then slightly widened just behind procoxae) with complete marginal stria, weakly emarginate at apex.

Elytra with mediobasal depression between humeral trichomes; humeral trichomes always present, usually consisting of elevated rounded lateral process ('disc') bearing setae along half or all of its inner (upper) margin; disc variously elaborated at its bases, particularly posteriorly, where it may be extended as an elongate elytral carina; setal fringe of trichome generally short, dense, directed mediad, but occasionally erect, and/or extremely elongated; each elytron with marginal stria continuous on all edges, invariably accompanied by an 'accessory epipleural stria,' which delineates upper arc of metathoracic leg; texture of epipleuron within (below) accessory stria frequently distinct (usually smoother) from that of surrounding epipleuron. Mesosternum generally short, wide, with complete, usually deeply impressed marginal stria, projecting at middle; disc of mesosternum impressed on either side of an elevated midline in some; mesometasternal and median metasternal sutures finely to deeply impressed; metasternal disc varied, from smooth to densely punctate, flat to markedly convex; leg depressions of meso- and metasterna shallow, delimited by elevated carinae; legs varied, femora slender and convex to broad and flattened; protibiae usually slender and angulate; meso- and metatibiae slender and angulate in some species, more typically broader,

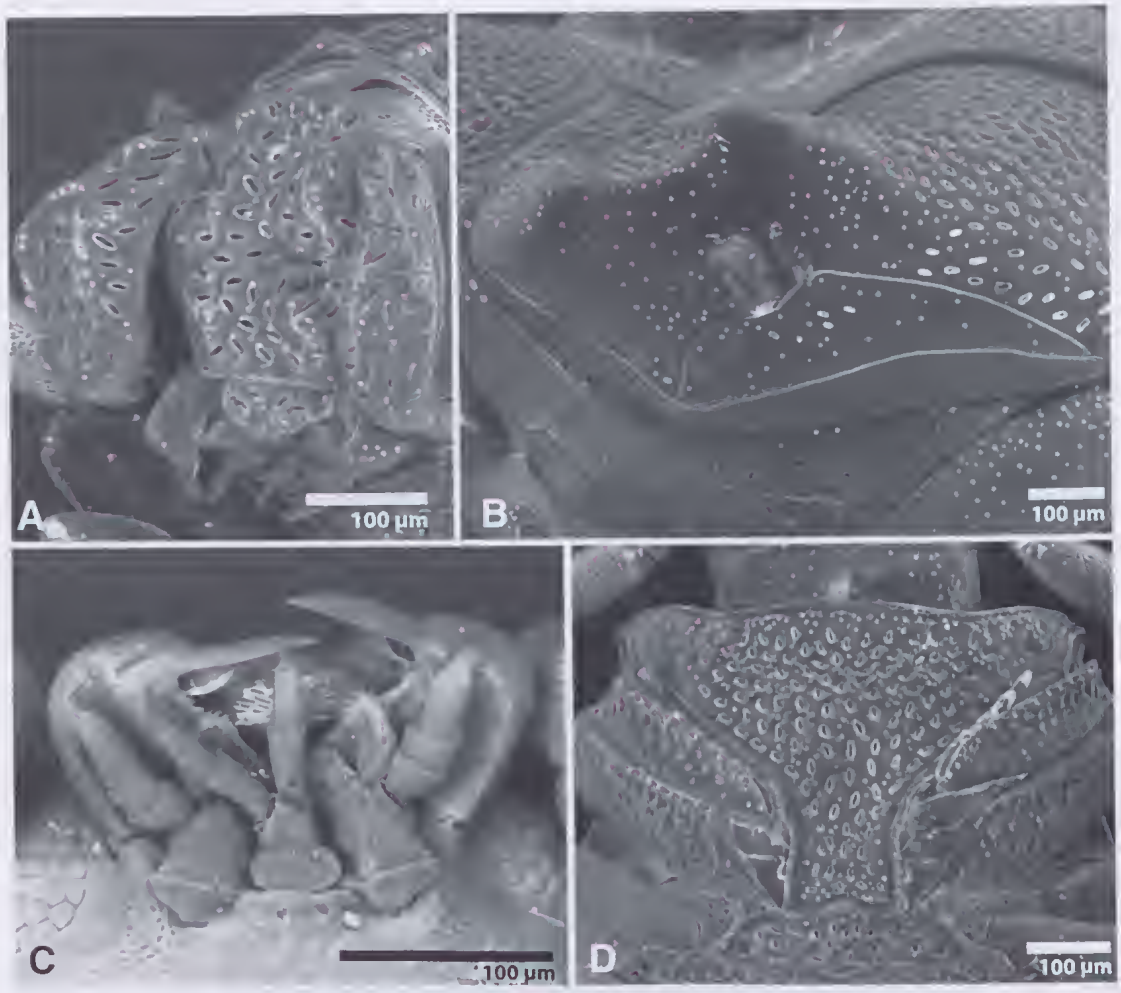


FIG. 8. Generic characters of *Chlamydonia*. A, Frontal tubercles of *Chlamydonia terapoides*. B, Accessory epipleural stria of *Chlamydonia sinuata*. C, Ventral view of mouthparts of *C. sinuata*. D. Prosternum of *C. sinuata*.

with outer margin bluntly angulate or rounded; tarsi weakly to strongly laterally compressed, with basal and apical tarsomeres subequal, tarsomeres 2-4 subequal, individually about half as long as apical tarsomere; basalmost tarsomere with ventral setae along most of length; tarsomeres 2-4 with long setae at ventral apex, and usually with shorter setae at dorsal apex; tarsal claws equal, simple, usually quite small, weakly to strongly arcuate.

Propygidium flat, evenly convex, or depressed along basal margin, length ranging from two-thirds to nearly full pygidial length, densely punctate in most, occasionally with conspicuous setae; pygidium flat to convex, to depressed at sides, generally similar in texture to propygidium or with punctures sparser, particularly diminishing in size and density toward apex.

Male genitalia undistinctive and similar in examined species, sternite 8 with apical setae; segment 9 elongate narrow, lateral components widely separated, curving weakly dorsad at apices; spiculum gastrale short, about one-third tegmen length, sclerotised only around edges, weakly hourglass shaped, basally with separate proximal apodemes, but with apical margin entire; basal piece about one-fourth tegmen length; tegmen slender, sides weakly sinuate, slightly expanded toward apex, then strongly narrowed, and abruptly curved ventrally to tip.

Female (two species examined); basal processes of segment 9 weakly outwardly arcuate, convergent proximally; valvifer of ovipositor spatulate at base; coxite about one-half length of valvifer, bidentate at apex; cylindrical gonostyle nearly reaching apex of coxite, bearing 4-5 long setae at apex.

REMARKS. The species of *Chlamydonia* fall into two superficially distinctive groups, one in which the elytral dorsum is densely punctate, and one in which it is entirely impunctate. However, strong similarities in trichome structure unite the two.

The similarities between *Chlamydonia* and the *Orectoscelis/Eucurtiopsis* lineage (also including *Pheidoliphila*, *Ceratohister*, and *Gomyopsis*) are suggestive of a close relationship, and worth additional discussion. The defining synapomorphy of the latter group is the fully hidden scutellum. In all of the latter taxa the base of the pronotum and elytra meet at a tight junction. The bases of the elytra diverge slightly toward the base, and this void is filled by an acute posterior extension of the pronotum. Examination of numerous specimens in which the head and prothorax have become separated from the rest of the body show clearly that the scutellum is entirely concealed from above. In *Chlamydonia*, while the elytral bases diverge similarly, and the scutellum is slightly or even strongly receded, the pronotum is not, or only barely produced posteriorly to fill the resulting opening. In all clean specimens, the scutellum can be seen within this opening. Specimens broken between the pro- and mesothorax, reveal a small bladelike dorsal scutellar edge, at approximately the level of the undersurface of the elytra. Differences in mouthpart structure also appear to clearly differentiate *Chlamydonia* from other Chlamydopsinae, although material available has been insufficient to be absolutely certain that these are consistent throughout either group. The labium of *Chlamydonia* exhibits a well sclerotised mentum, which is flat, coplanar with the submentum, and separate from the prementum. There are also 3 distinct labial palpomeres, although the basal one is short and difficult to see in undissected specimens. In all members of the *Orectoscelis* lineage examined, the labium lacks a distinct mentum (it is unclear whether it is fused with the projecting submentum, or incorporated into the prementum) and bears 2-segmented palpi.

Chlamydonia seems similarly transitional in prosternal structure. In all species the depression for reception of the prothoracic leg extends from the base approximately two-thirds of the way to the anterior margin, with the lateral portion of the prosternal disc (and hypomeron) distinctly elongated, relative to that of *Chlamydopsis*. Yet in no species of *Chlamydonia* does this elongation approach that seen in species of the *Orectoscelis* lineage, where the prothoracic leg depression is restricted to the basal half of the prosternum or less. The prosternal keel of *Chlamydonia* is also relatively narrow and retains the (plesiomorphic) acute basal emargination for the reception of the mesostemum. All of these features strongly suggest an intermediate position of *Chlamydonia* between *Chlamydopsis* and the *Orectoscelis* lineage, close, and probably sister group to the latter.

Chlamydonia sol sp. nov.
(Figs 9, 10A, 11A)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 8910, 22°21'S × 166°58'E, Port Boise (G.Kanua), 22 Nov 2001-29 Jan 2002, G.B.Monteith, FIT trap; in MNHN. PARATYPES (2 ♂ ♂): 1: same data as type; 1: NEW CALEDONIA 8937, 22°20'S, 166°55'E, Kwa Neie summit, 500m, 22 Nov 2001-30 Jan 2002, G.B. Monteith, FIT trap; in QM and MSCC.

DIAGNOSIS. This species and the following four are quite similar, sharing a trichome structure in which a more or less laminate longitudinal disc arises from the basal half of the outer edge of each elytron, bearing a dense but short fringe of golden setae along its upper apical margin. This structure is also shared by the related, but otherwise superficially dissimilar *C. eucurtiopsoides*. In *C. sol* and *C. coutume* this disc extends from the humeral elytral corner to or just slightly beyond the elytral midpoint, whereas in *C. gomyi*, it terminates posteriorly distinctly short of the longitudinal midpoint. In *C. tjibaoui*, the disc is distinctly longer, extending about two-thirds the elytral length. In *C. sol* this disc is inclined mesally, about 30° off vertical, and its outer and upper surfaces are more or less evenly convex. In both *C. coutume* and *C. gomyi*, the disc is more deeply inclined (approximately 45° and 60° off vertical, respectively), and in the latter species, the convexity of the lateral surface is broken by a distinct ridge, above which the disc is weakly concave. In *C. tjibaoui*, the outer and upper surfaces of the disc are evenly convex, but its apex is inclined to fully horizontally. In *C. foveata*, the trichome disc is very similar in form to that of *C. gomyi*, reaching near the elytral midpoint, but its trichome fringe is erect, projecting dorsoposterad,

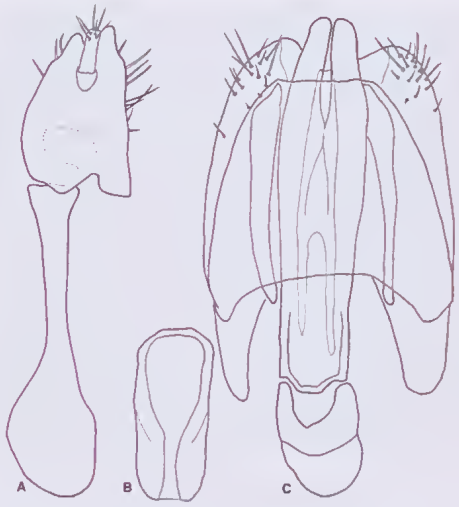


FIG. 9. Genitalic characters of *Chlamydonia*. A, Ovipositor (valvifer and coxite) of female *C. sol.* B, Spiculum gastrale (S9) of male *C. sol.* C, Aedeagus, abdominal tergites 8 and 9, and sternite 8 of *C. sol.*

and is unkempt, rather than neat and inwardly projecting. The median pronotal projections are also very weak in *C. foveata*.

DESCRIPTION. L: 1.53; W: 1.28; E/Pn L: 1.97; E/Pn W: 1.52; Pn W/L: 1.64; E L/W: 0.79; Pr/Py: 0.94; Sterna: 0.53, 0.08, 0.42; Tibiae: 0.53, 0.59, 0.59. Body subquadrate, dark rufescent brown, most surfaces densely and deeply punctate, glabrous apart from setae of trichome. Frons about 1.2x as long as wide, sides rounded, indented at antennal insertions, disc with 2 longitudinal series of glabrous tubercles, 2-3 per series in types, frontal disc otherwise densely punctate, with irregular, rugose microsculpture between punctures: labrum semicircular, with few small punctures and rugose microsculpture; antennal scapes bluntly angulate near middle of outer margin, convex and thickened along inner edge (oriented as retracted), thinner, somewhat explanate laterally, densely punctate and microrugose; antennal club of male about 1.2x as long as scape, female not known.

Pronotum transverse, slightly wider at base than apex, sides unmargined, weakly inwardly arcuate; anterior margin with small tubercle on either side, separated by about one half frontal width, and erect, oblique lateral flange extending from above inner corner of antennal cavity posterolaterally about halfway to lateral pronotal margin; pronotal disc densely covered with slightly oblong punctures, separated by about one-fourth their widths. Prosternum densely punctate except at extreme sides in front of procoxal depressions, narrowed, and slightly depressed between coxae, keel emarginate at base; prosternum with marginal stria continuous around all edges.

Elytra more or less parallel sided, transversely depressed in middle of basal one-fourth, convex posteriorly, with prominent humeral trichomes; trichome formed mainly of elevated rounded semicircular disc, extending posteriorly from humeral corner to about elytral midpoint, disc transversely incised at anterior and posterior bases, bearing dense, continuous, inwardly directed fringe of golden setae along entire dorsal edge, as well as opposing fringe from opposite edges of incisions; cavity beneath trichome fringe smooth, broadly open mesally, with small deeper cavity, about one-third diameter of large median opening, undercutting it further from middle; a fine ridge curving posterolaterally from posterior corner of trichome, separating dorsal portion of elytral disc from epipleuron, diminishing to posterior elytral corner; dorsal portion of elytral disc densely punctate except immediately beneath trichome fringe within mediobasal depression; lateral (outer) surface of trichome densely punctate, becoming punctatorugose along lower base of trichome disc, epipleuron otherwise only shallowly and faintly punctate, impunctate within accessory epipleural stria; elytron with marginal stria continuous on all edges.

Mesosternum short, about 5x as wide as median length, elevated along midline and lateral margins, but deeply depressed on either side, punctatorugose within depressions, with blunt anterior projection at middle; mesometasternal suture not impressed; postmesocoxal stria extending from inner edge of mesocoxa to metepisternum, delimiting mesothoracic leg depression; longitudinal metasternal suture finely impressed, metasternum sparsely punctate at middle, punctures separated by 2-3x their widths, becoming somewhat more dense toward sides, surface between punctures appearing smooth, but with fine polygonal microsculpture visible at higher magnifications; first visible abdominal sternite moderately densely punctate (notably less densely than prosternum), punctures separated by about one-half their widths; postmetacoxal stria extending from inner corner of metacoxa to edge of elytron, delimiting metathoracic leg depression. Lower (posterior) surfaces of profemur and protibia densely

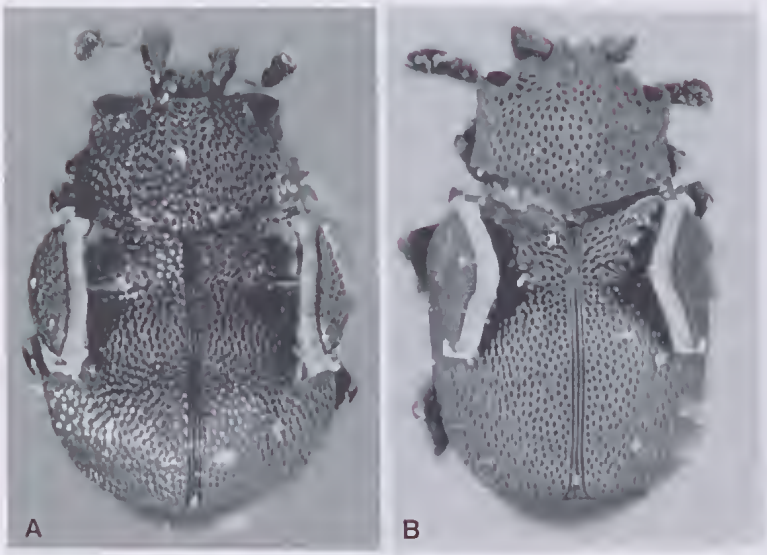


FIG. 10. Dorsal views of *Chlamydonia* spp. A, *C. sol* sp. nov.; B, *C. coutume* sp. nov.

punctate; lower (anterior) surfaces of meso- and metafemora and tibiae with very sparse, minute setigerous punctures; lateral edge of protibia angulate about one-third from base, maximum width about one-third tibial length, evenly tapered to narrow apex; meso- and metatibiae more bluntly angulate, arcuate to apex; tarsi laterally compressed, tarsomeres 1-4 apically oblique, apicoventrally acute; tarsal claws equal, fine, short.

Propygidium faintly convex, with deep oblong punctures separated by about their widths; pygidium nearly flat, with punctures separated by 1.5-2x their widths; pro- and pygidial surfaces with very fine polygonal microsculpture between punctures.

Chlamydonia coutume sp. nov.
(Figs 10B, 11B, 28B)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 8904, 20°58'S × 165°17'E, 500m, Pie d'Amoa, N slopes, 24 Nov 2001-31 Jan 2002, G.B. Monteith, FIT trap; in MNHN.

DIAGNOSIS. This species and the next three are diagnosed with *C. sol* above. In *C. coutume* the fringe-bearing edge of the trichome disc is inclined about 45° off vertical, and its outer surface is more or less evenly convex, with the coarse dorsal punctures fading gradually into dense microgranulation on the epipleural surface. This species lacks the posterolateral ridge separating the posterodorsal portion of the elytral disc from the epipleuron, present in both the preceding and the following species, and the epipleuron is entirely punctatorugose above the accessory epipleural stria (though impunctate between this stria and the marginal epipleural stria). Of these five species, only in this species and *C. tjibaoui* is the medial portion of the metasternal disc densely and uniformly punctate (as compared with the lateral portion of the metasternum).

DESCRIPTION. L: 1.40; W: 0.44; E/Pn L: 2.21; E/Pn W: 1.38; Pn W/L: 1.61; E L/W: 1.00; Pr/Py: 0.89; Sterna: 0.47, 0.08, 0.37; Tibiae: 0.47, 0.50, 0.51. This species is very closely related to *C. sol*, above, and is described only to the extent that they differ. DISC of frons with two longitudinal series of glabrous tubercles, 2 per series in type, and additional smaller projections at antennal bases; frontal disc otherwise densely punctate; antennal

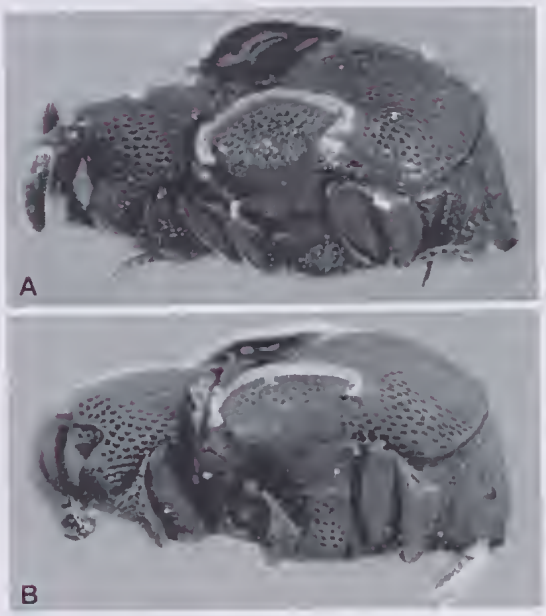


FIG. 11. Lateral views of *Chlamydonia* spp. A, *C. sol* sp. nov.; B, *C. coutume* sp. nov.

scape with fewer discrete punctures, though entirely granulately microsculptured. Medial pair of pronotal tubercles distinct at anterior pronotal margin, only very indistinctly continued posteriorly. Humeral trichome with outer disc rounded over, marginal setal fringe extending horizontally, its outer surface more or less evenly convex, with coarse punctation of upper surface grading into finely granulate lateral surface; elytron lacking posterolateral ridge extending from posterior base of trichome disc, dense punctation of posterior portion of elytral dorsum extending laterally to accessory epipleural stria; epipleuron impunctate, with only fine polygonal microsculpture between accessory stria and marginal stria. Metasternal disc uniformly punctate, with punctures separated by about 0.5x their widths; mesosternum and anterolateral corners of metasternum somewhat depressed relative to central part of metasternal disc.

REMARKS. This species name references 'La coutume', or the native Kanak code of social conduct.

Chlamydonia gomyi sp. nov.
(Figs 12A, 13A)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 8919, 22°17'S × 166°54'E, Pic du Grand Kaori, 21 Nov 2001 - 29 Jan 2002, G.B. Monteith. FIT trap; in MNHN. PARATYPES (12♂♂), 2: same data as type; 1: NEW CALEDONIA 8902, 22°15'S, 166°49'E, 280m, Pic du Pin, east base, 21 Nov 2001 - 27 Jan 2002, G.B. Monteith. FIT trap; 1: NEW CALEDONIA 11865, 22°14'S, 166°50'E, 280m, Pic du Pin, site2, intercepts, 25 Nov 2004 - 12 Jan 2005, G.B. Monteith, Grimbacher, RF; 1: NEW CALEDONIA 11853, 22°17'S, 166°53'E, 250m, Pic du Grand Kaori,site2, 22 Nov 2004 - 12 Jan 2005, G.B. Monteith, Grimbacher, intercept traps, rainforest; 4: NEW CALEDONIA 11847, 22°17'S, 166°53'E, 250m, Pic du Grand Kaori,site1, 22 Nov 2004 - 12 Jan 2005, G.B. Monteith, Grimbacher, intercept traps, rainforest, 3: NEW CALEDONIA 11889, 22°19'S, 166°55'E,200m, Foret Nord, site 2, intercepts, 2 Dec 2004 - 9 Jan 2005, G.B. Monteith, Grimbacher, RF; in QM and MSCC.

DIAGNOSIS. See diagnosis under *C. sol*, above. The humeral trichome of this species differs in several subtle respects from that of the preceding two. The most distinctive of these is a discrete break between the dense punctation of the dorsal surface of the trichome disc and the fine granulation of the lateral portion (on the epipleuron). This division is marked by a weak ridge, and is also reflected in a change from lateral convexity to weak dorsal concavity. This species is also distinct in having a small, round section of the marginal trichome fringe pinched off from the remainder at its anterolateral (and to a lesser degree posterolateral) extreme. The resulting isolated bundle of setae extends laterally at its base, with the apex curving dorsad. The entire trichome structure is somewhat shorter, clearly not attaining the elytral midpoint.

DESCRIPTION. L: 1.47; W: 1.06; E/Pn L: 1.85; E/Pn W: 1.42; Pn W/L: 1.45; E L/W: 0.90; Pr/Py: 1.13; Sterna: 0.50, 0.08, 0.37; Tibiae: 0.44, 0.50, 0.50. This species is very closely related to *C. sol*, above, and is described only to the extent that they differ. Frons with two pairs glabrous tubercles, with additional smaller projections at antennal bases; antennal scape with only faint shallow punctures in basal half, becoming more distinctly punctate apically, with polygonal to granulate microsculpture throughout. Medial pair of pronotal tubercles prominent at anterior pronotal margin, extended posteriorly by carinae about one-fifth pronotal length, with additional discal tubercles just detectable posterolateral to apices of these carinae; anterolateral (supra-antennal) alae well developed; pronotum of some individuals with indistinct marginal ridge extending a short distance posteriorly from lateral-most point of antennal cavity. Humeral trichome with longitudinal lateral disc extending from humeral elytral corner to near elytral midpoint; disc inclined inwardly about 60° off vertical, its dorsal, densely punctate and shallowly concave portion set off from lateral, finely granulate, convex portion by weak ridge; marginal setal fringe of trichome disc with small round section pinched off at both anterior and posterior extremes, resulting bundles of setae directed laterally at their bases (nearly opposite those of adjacent portion of main body of fringe), curving dorsally at their apices; cavity beneath trichome fringe reduced in depth (relative to preceding two species) by laterally thickened trichome disc, no deeper than basal edge of marginal fringe, opening within this cavity reduced to small pit extending into trichome from floor of mediobasal elytral depression; epipleuron granulate on outer surface of trichome, granulation stopping short of marginal (anteriorly) and accessory epipleural striae, with few coarse punctures between; posterolateral ridge present, curving posterolaterally from posterior corner of trichome, extending to and merging with posterior margin of elytron (though frequently interrupted along its length) separating dorsal portion of elytral disc from epipleuron, epipleuron slightly less densely punctate than elytral dorsum;

epipleuron with few (3-5) small punctures in space between marginal and accessory striae.

REMARKS. This species is named for Yves Gomy, in recognition of his contributions to our knowledge of histerid diversity in New Caledonia.

Chlamydonia tjibaoui sp. nov.
(Figs 12B, 13B)

MATERIAL. HOLOTYPE probably ♀: NEW CALEDONIA 11420, 21°45'S × 166°00'E, Mt Do summit, 1000m. 22 Nov 2003. G.B. Monteith, Pyrethrum trees & logs; in MNHN.

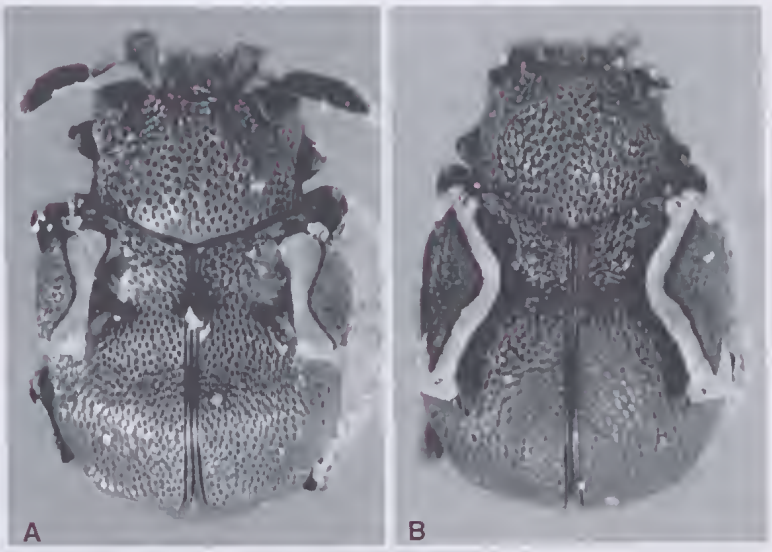


FIG. 12. Dorsal views of *Chlamydonia* spp. A, *C. gomyi* sp. nov.; B, *C. tjibaoui* sp. nov.

DIAGNOSIS. *Chlamydonia tjibaoui* is in some respects the most distinctive of the group diagnosed under *C. sol*, above. Most distinctively, the trichome disc is elongate, reaching from the humeral corner about two-thirds the total length of the elytra. Unlike the above species the transverse incisions at the anterior and posterior origins slightly undercut the base of the disc (a clear similarity to several species below). The sternal and abdominal ground texture is unique in this species relative to any others treated in this paper, with conspicuous polygonal microsculpture throughout, even within the punctures. This is particularly distinctive on the metasternum and pygidia, due mainly to the lower density of punctures on these surfaces.

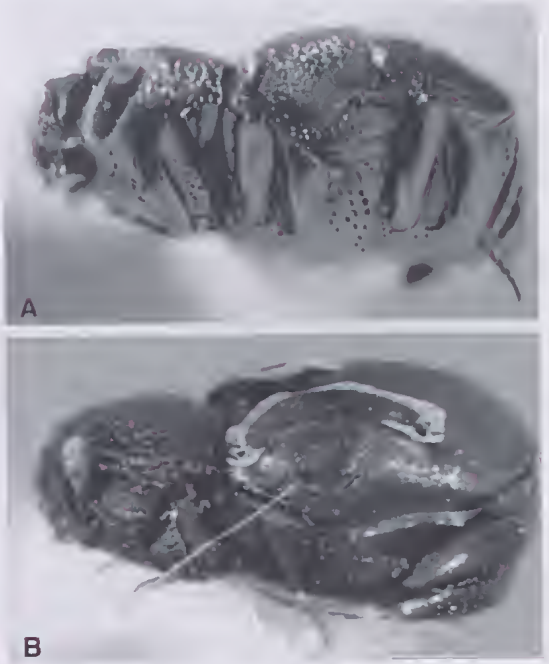


FIG. 13. Lateral views of *Chlamydonia* spp. A, *C. gomyi* sp. nov.; B, *C. tjibaoui* sp. nov.

DESCRIPTION. L: 1.53; W: 1.11; E/Pn L: 1.80; E/Pn W: 1.58; Pn W/L: 1.29; E L/W: 0.89; Pr/Py: 1.13; Sterna: 0.50, 0.06, 0.39; Tibiae: 0.44, 0.48, 0.53. This species is described only to the extent that it differs from *C. sol*, above. Frons with 4 weak discal tubercles, in addition to 2 of similar size at bases of antennae; frons deeply punctate, with microsculpture evident throughout; lateral and median carinae of pronotum similar in size, rather weakly developed, gradually diminishing from anterior margin posterad for about one-fourth pronotal length; pronotum without any lateral margin; elytron with humeral trichome very prominent, extending from anterior corner two-thirds length of elytron, disc curving evenly inward from nearly vertical epipleuron to nearly horizontal at apex, almost reaching midpoint of each elytron; trichome disc subtriangular, with anterior and posterior edges nearly straight, bluntly angulate at apex, marginal fringe short, neat, and inwardly directed; anterior and posterior transverse incisions at trichome base expanded beneath trichome disc, undercutting its anterior

and posterior one-fifth, setal fringe continuous along these edges as well; trichome open beneath overhanging inner edge of disc, with large, deeper fovea at middle; posterolateral corner of trichome extended by simple carina which continues weakly to merge with apical elytral margin; epipleuron densely but finely punctatorugose beneath trichome, becoming impunctate, with only ground microsculpture evident, toward lateral margin; few fine punctures present within accessory epipleural stria. Prosternum very densely punctate, with microsculpture throughout; mesosternum depressed, densely punctate; metasternum convex, uniformly punctate, but much less densely so than prosternum, with polygonal microsculpture conspicuous; density of punctures of first visible abdominal sternum intermediate between that of pro- and metasternum.

REMARKS. This species name honours Jean-Marie Tjibaou, leader and advocate for the native Kanak people and culture, who was assassinated in 1989.

Chlamydonia foveata sp. nov.
(Figs 14A, 15A)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 11476, 21°35'S × 165°48'E, 400m. Col d'Amieu, sawmill. 25 Nov 2003 - 27 Jan 2004, G.B. Monteith, flight int. trap.; in MNHN. PARATYPE, 1 ex. (sex uncertain): same data as type; in QM.

DIAGNOSIS. This species is distinguished by its short and continuous, but erect trichome fringe, in combination with densely punctate elytra. In all of the above species, the trichome fringe is directed mesad along the inner edge of the trichome disc. In a few species below, the fringe is suberect to erect, but these have either discrete bundles of very elongate setae (*C. erectipilosa* and *C. stellata*), or impunctate elytra (*C. eucurtiopsoides*).

DESCRIPTION. L: 1.62; W: 1.22; E/Pn L: 2.06; E/Pn W: 1.47; Pn W/L: 1.56; E L/W: 0.90; Pr/Py: 1.00; Sterna: 0.53, 0.06, 0.44; Tibiae: 0.53, 0.58, 0.59. Frons with 2 pairs of tubercles, anterior-most pair more distinct, upper pair weak, longitudinally diffuse, with very weak additional pair near vertex between antennal bases; median pronotal processes weak, short carinae, distinct anteriorly, gradually becoming obsolete about one-fifth from anterior margin; lateral pronotal alae slightly more strongly developed, oblique, extending from anterior margin to about posterior midpoint of antennal cavity; pronotal disc densely covered with elongate punctures, smooth and shining between punctures; prosternum with anterior margin slightly widened beneath head, marginal bead with dense microsculpture; prosternal disc deeply and densely punctate, with conspicuous microsculpture between punctures. Elytra with humeral trichomes extending from anterobasal corner posterad nearly to elytral midpoint, and mediad over about lateral one-third of each elytron, anterior and posterior basal incisions expanded laterally, slightly undercutting rounded trichome disc; disc rounded over to nearly horizontal dorsal surface, dorsal surface not separated from lateral by a carina; trichome with continuous short fringe along inner margin, projecting upward and curving posterad over much of its length, though reclinate to suberect at basal incisions (may be expected to look differently in life); trichome not broadly open beneath fringe, elevated disc solid beneath, with only small fovea below midpoint of disc; posterolateral corner of trichome with low ridge extending obliquely downward onto epipleuron, ending freely, posteromedial corner with more distinct carina extending posteromesad about one-fourth distance from trichome to posterior elytral margin; elytral disc uniformly densely punctate except immediately beneath trichome; epipleuron shallow rugose at base of trichome disc, more densely punctate along basal margin and above accessory epipleural stria posteriorly, impunctate within accessory stria. Mesosternum deeply depressed behind anterior marginal stria and on either side of elevated midline, densely punctate; mesometasternal and median metasternal sutures finely impressed; central portion of metasternal disc convex, with deep elongate punctures separated by about 3x their widths, becoming denser at sides, with rather faint polygonal microsculpture between punctures; first visible abdominal sternite weakly depressed, densely punctate, with punctures separated by about their widths. Legs with femora slender, profemur with margins sinuate, but more or less parallel, meso- and metafemora with anterior margins weakly arcuate, posterior margins straight, with depressed marginal stria; protibia slender, outer margin angulate about one-third from base; meso- and metatibia slightly broader, more bluntly angulate. Propygidium and sides of pygidium similarly densely punctate, the

midline, particularly apically, with punctures sparser.

Chlamydonia inflata sp. nov.
(Figs 14B, 15B)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 11476, 21°35'S × 165°48'E, 400m. Col d'Amieu, sawmill. 25 Nov 2003 - 27 Jan 2004, G.B. Monteith, flight int. trap.; in MNHN.

DIAGNOSIS. This species and the following, *C. densa*, are quite similar, and also share many features with *C. foveata*. All three have a small trichome disc undercut by expanded anterior and posterior basal incisions, a relatively short trichome setal fringe, and densely punctate elytra. *Chlamydonia eucurtiopsoides*, *C. punctinota*, and *C. fauveli* have a similar trichome, but their elytra are virtually impunctate. *Chlamydonia foveata* is easy to separate from *C. inflata* and *C. densa* by its distinctly erect trichome fringe. In *C. inflata* and especially *C. densa*, the trichome fringe is denser, but along the inner edge the setae are all directed inward rather than upward. These two species can be separated by the size of the trichome disc, which is smaller in *C. densa* (though its fringe is relatively more conspicuous, filling the resulting larger anterior and posterior incisions), and by the density of elytral punctation, which is greater in *C. densa*. Also, in this latter species the elytral punctures are almost uniformly subcontiguous, whereas in *C. inflata*, they are distinctly separated, with smooth flat integument between. This is particularly evident behind the trichomes.

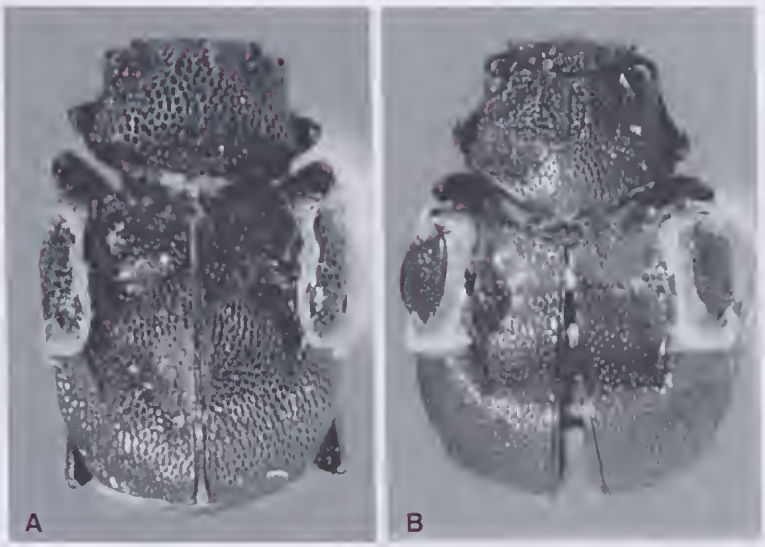


FIG. 14. Dorsal views of *Chlamydonia* spp. A, *C. foveata* sp. nov.; B, *C. inflata* sp. nov.

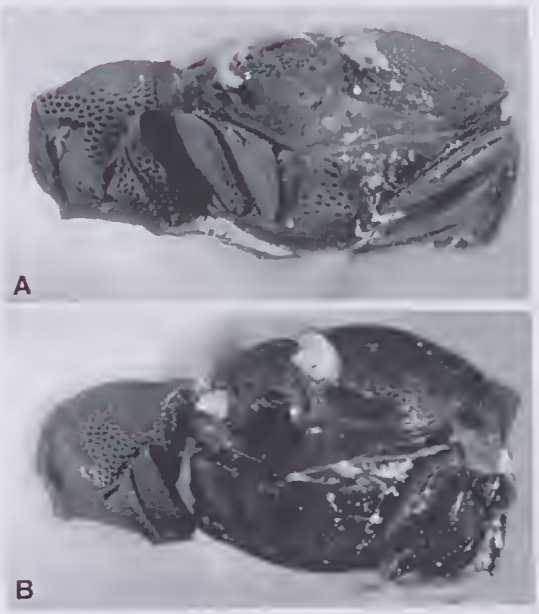


FIG. 15. Lateral views of *Chlamydonia* spp. A, *C. foveata* sp. nov.; B, *C. inflata* sp. nov.

DESCRIPTION. L: 1.95; W: 1.31; E/Pn L: 1.98; E/Pn W: 1.24; Pn W/L: 1.62; E L/W: 0.99; Pr/Py: 0.72; Sterna: 0.50, 0.09, 0.56; Tibiae: 0.87, 0.84, 0.94. Frons with sides strongly arcuate (beneath angulately emarginate antennal insertions) densely punctate, with prominent pair of tubercles immediately above labrum; additional pair nearer vertex slightly closer together, less prominent, and weakly contiguous with short carinae between antennal bases; labrum subtriangular, apex rounded, shallowly punctate; antennal scapes subtriangular, widest near middle, depressed along outer edge, particularly near widest point, shallowly punctate, punctures slightly less dense than those of frons.

Pronotum strongly convex dorsally, with sides narrowed from base, widened slightly around antennal cavities, laterally unmargined; median pronotal processes weakly developed as short carinae; lateral marginal pronotal processes

slightly more strongly developed; pronotal disc also with weak tubercles just behind middle separated by about head width. Prosternum with anterior margin weakly sinuate, with marginal stria at sides but obsolete beneath head; prosternal keel with edges elevated, depressed at middle, with complete marginal stria; entire prosternal disc densely punctate.

Elytra with humeral trichomes extending from anterobasal corner posterad nearly to elytral midpoint, and mediad over about lateral one-third of each elytron, its epipleural surface strongly convex, curving inward to about 45° off vertical, dorsal surface not separated from lateral by a carina; anterior and posterior basal incisions expanded at epipleural side, slightly undercutting rounded trichome disc; trichome with continuous bushy fringe along inner margin, projecting horizontally, with conspicuous opposing fringe on opposite edges of anterior and posterior incisions; trichome not broadly open beneath fringe, elevated disc solid beneath, median fovea lacking from inner surface of trichome; posteromedial corner of trichome slightly elevated, a weak oblique ridge leading to inner corner; elytral disc moderately densely punctate along sutural margin, less so behind trichome, and impunctate immediately beneath trichome; epipleuron entirely impunctate; trichome disc impunctate on outer base, with only few shallow punctures at dorsalmost edge.

Mesosternum depressed behind marginal stria, weakly projecting at middle; densely punctate; mesometasternal and median metasternal sutures finely impressed; metasternal disc moderately densely punctate at sides and in anterior corners, but with median portion of disc quite sparsely punctate, punctures separated by 2-3x their widths, intervening integument shining, with faintly evident polygonal microsculpture. First visible abdominal sternite with punctures denser, separated by slightly less than their widths. Legs with femora slender, profemur with margins sinuate; meso- and metafemora with anterior margins weakly arcuate, posterior margins straight, with depressed marginal stria; protibia slender, outer margin angulate about one-third from base; meso- and, moreso, metatibia slightly broader, only faintly convex along main axis, more bluntly angulate.

Propygidium with basal punctures separated by about their widths, becoming slightly more widely separated to apex; punctures of pygidium markedly shallower, becoming almost obsolete to apex.

REMARKS. This species name refers to the strongly convex pronotum and epipleural surfaces.

Chlamydonia densa sp. nov.
(Figs 16A, 17A)

MATERIAL. HOLOTYPE ♂ (head and prothorax off body, mounted at base of same point): NEW CALEDONIA 11482, 20°58'S × 165°17'E, 500m, Pic d'Amoa, N slopes. 27 Nov 2003 - 30 Jan 2004. G.B. Monteith, flight int. trap.; in MNHN.

DIAGNOSIS. See diagnosis under *C. inflata*, above.

DESCRIPTION. L: 1.40; W: 1.12; E/Pn L: 1.81; E/Pn W: 1.50; Pn W/L: 1.50; E L/W: 0.81; Pr/Py: 1.06; Sterna: 0.47, 0.06, 0.39; Tibiae: 0.44, 0.48, 0.53. This species is very similar in most respects to *C. inflata*, above. It differs as follows: median pronotal processes very weak, little more than marginal tubercles; posterolateral pronotal discal tubercles barely evident; elytra more densely punctate, with punctures subcontiguous nearly throughout, obsolete only beneath humeral trichomes and on epipleurae; elevated trichome disc smaller, sclerotised portion only about one-third elytral (sutural) length; anterior and posterior basal incisions of trichome broad, more deeply undercutting trichome disc, with trichome fringe, dense, continuous, conspicuously projecting from all edges; dorsolateral surface of trichome disc with punctures from upper edge down just beyond lateral constriction, then obsolete on epipleural convexity; metasternal disc uniformly more densely punctate, with punctures separated by slightly more than their widths; meso- and metatibiae more slender, nearer angulate than arcuate along outer edge, more distinctly convex along main axis.

Chlamydonia stellata sp. nov.
(Figs 16B, 17B)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 11482, 20°58'Sx165°17'E, 500m, Pic d'Amoa, N slopes. 27 Nov 2003 - 30 Jan 2004. G.B. Monteith, flight int. trap.; in MNHN.

DIAGNOSIS. This species and the following, *C. erectipilosa* are very distinctive among *Chlamydonia* for their erect, elongate trichome fringe. In both a continuous elongate fringe arises dorsad from the entire edge of the trichome disc, including anterior and posterior opposing edges. In addition both possess separate elongate 'bundles' of setae on the dorsal surface of

the triehome dise parallel to the marginal fringe. In *C. stellata* there are 3 of these aeeessory bundles on eaeh side, whereas on *C. erectipilosa* there are 4. This speeies is more readily distinguished from *C. erectipilosa* by its punetate elytra, while those of *C. erectipilosa* are almost entirely impunetate, with only a few ineonspieuous shallow punetures along the suture. It is worth noting that in the types of both of these speeies the eontinuous setal fringe of the triehome margin appears elumped into bundles as well. However, I suspeet this is an artefaet of preservation, and that in life these setae would be more evenly distributed. The aeeessory 'bundles' of setae deseribed here have very distinetly separate origins from eaeh other (though they are subeontiguous at their inner edges with the marginal fringe).

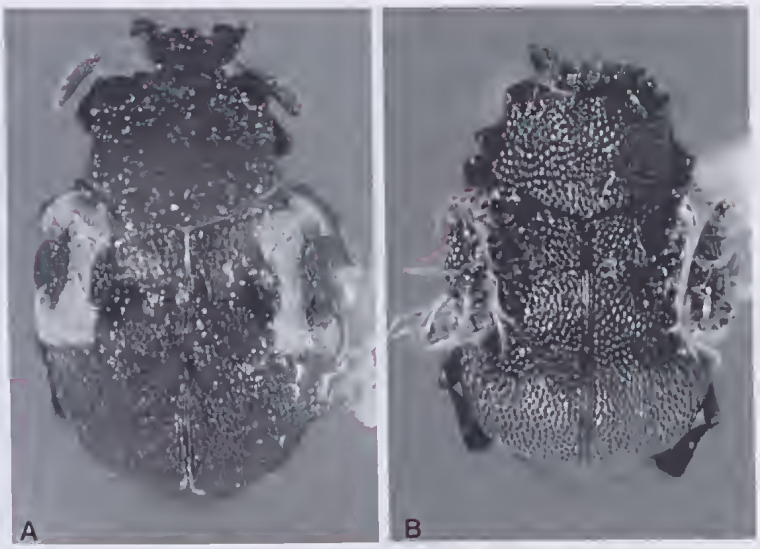


FIG. 16. Dorsal views of *Chlamydonia* spp. A, *C. densa* sp. nov. (head reattached to body digitally). B, *C. stellata* sp. nov.

DESCRIPTION. L: 1.50; W: 1.15; E/Pn L: 2.00; E/Pn W: 1.48; Pn W/L: 1.56; E L/W: 0.86; Pr/Py: 0.94; Sterna: 0.50, 0.06, 0.41; Tibiae: 0.48, 0.56, 0.59. Body dark, faintly rufeseent, with bronzy tinge; frons with two pairs of similar, prominent tubereles; tubereles between antennal bases nearly as well developed, elearly separate from dorsalmost frontal pair; sides of frons angulately emarginate at antennal insertions, widest immediately below, narrowed evenly to epistomal suture, weakly areuate; frontal dise uniformly eovered with elongate punetures, with intervening polygonal mieroseulpture; labrum subtriangular, rounded at apex, faintly punetatorugose; antennal seape subtriangular, widest at midpoint, outer edge bluntly angulate, eonvex along main axis, slightly flattened to margin; antennal funiele (of male) about two-thirds length of seape, antennomere 2 eylindrieal, antennomere 3 narrow at base, enlarged to apex, as long as antennomeres 4-8 eombined; antennal club about as long as seape, densely pubeseent.

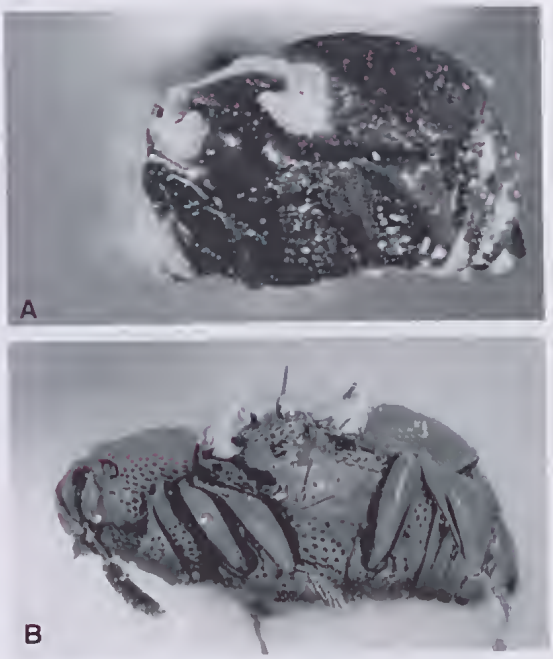


FIG. 17. Lateral views of *Chlamydonia* spp. A, *C. densa* sp. nov. B, *C. stellata* sp. nov.

Prothorax with sides unmargined, inwardly areuate, narrowest just in front of middle; median marginal proeesses produeed as weak earinae extending from anterior margin about one-fourth length of dise; lateral proeesses oblique, similar in length to median pair, slightly more strongly produeed; posterolateral pronotal tubereles faintly evident; pronotal dise densely and uniformly punetate. Prosternum with anterior margin weakly sinuate, marginal stria evident, but weak at middle, with marginal bead flat and

slightly widened; prosternal keel weakly depressed between procoxae; prosternal disc deeply and densely punctate, with conspicuous microsculpture between and within punctures.

Elytra with humeral trichomes extending from anterobasal corner posterad to elytral midpoint, and mediad over lateral one-third of each elytron, its epipleural surface weakly convex, curving inward to nearly horizontal, dorsal surface not separated from lateral by a carina; anterior and posterior basal incisions expanded at epipleural side, slightly undercutting trichome disc; trichome with erect, elongate setal fringe along inner margin, with accessory bundles of elongate setae parallel to marginal fringe; trichome not broadly open beneath fringe, with small median fovea on inner surface of trichome; elytral disc uniformly densely punctate on dorsal surface; epipleuron more shallowly punctate posteriorly, and with epipleural surface of trichome disc impunctate nearly to epipleural margin.

Mesosternum short, slightly depressed behind nearly straight anterior marginal stria, with single transverse series of deep punctures; mesometasternal and median metasternal suture finely impressed; metasternal disc sparsely and only finely punctate at middle, with few larger punctures anteriorly and at sides, with faint polygonal microsculpture on impunctate surface; first visible abdominal sternite with deep punctures separated by about their widths along anterior margin, becoming shallower and more widely separated posteriorly. Legs with femora slender, profemur densely punctate on lower (posterior) surface, meso- and metafemora with only sparse, fine setigerous punctures on lower (anterior) surfaces, with marginal stria along posterior edges; protibia slender, outer margin angulate about one-third from base; meso- and metatibiae broader, bluntly angulate nearer midpoint of outer margins.

Propygidium densely, though rather shallowly, punctate, with punctures separated by slightly more than their widths, with faint microsculpture on intervening integument; pygidium similarly punctate at base, punctures becoming sparser but not obsolete toward apex, with microsculpture more conspicuous than that of propygidium.

Chlamydonia erectipilosa sp. nov.
(Figs 18A, 19A)

MATERIAL. HOLOTYPE ♀: NEW CALEDONIA 8910, 22°21'S × 166°58'E, Port Boise (G. Kanua), 22 Nov 2001 - 29 Jan 2002, G.B. Monteith, FIT trap; prothorax and head off body, mounted on same point; in MNHN.

DIAGNOSIS. See diagnosis under *C. stellata* above.

DESCRIPTION. L: 1.75; W: 1.34; E/Pn L: 1.80; E/Pn W: 1.65; Pn W/L: 1.30; E L/W: 0.84; Pr/Py: 0.77; Sterna: 0.56, 0.08, 0.44; Tibiae: 0.47, 0.50, 0.53. Body rufescent, with fine, sparse setae on most surfaces. Frons relatively short, nearly as wide as long, widest just below antennal insertion, convergent to epistomal suture; frontal disc with two pairs of tubercles as above, plus several smaller tubercles, two corresponding to those found between antennal bases in other *Chlamydonia*, others irregularly arranged and without homologues, all with cluster of setae at their apices; frontal disc otherwise densely punctate; labrum subtriangular, rounded at apex, with small setigerous tubercle; antennal scape rather slender, strongly curved at base, outer edge bluntly angulate at midpoint; antennal funicle and club subequal in length, each about two-thirds length of scape.

Prothorax widest at base, narrowed to front, widening just slightly at antennal cavities; median pronotal processes barely produced as vague swellings at anterior margin; lateral pronotal processes produced as low oblique carinae, extending from anterior margin posterad about one-fifth pronotal length; pronotal disc with elongate punctures separated by slightly less than their widths, with smaller setigerous punctures interspersed; ground texture of pronotal disc smooth, without any evident microsculpture. Prosternum with anterior margin sinuate, broadly arcuate beneath head, anterior marginal stria obsolete across middle (though extreme edge is faintly rugose, appearing striate), with wide smooth marginal bead lacking large punctures, but with small setigerous punctures; prosternal disc similar in texture to pronotum, densely punctate with interspersed setigerous punctures, most bearing scale-like setae; prosternal keel shallowly impressed between procoxae, with posterior marginal stria very close to edge.

Elytron with prominent humeral trichome, extending from anterolateral corner posterad about two-thirds elytral length, consisting of elevated, near vertical rounded lateral disc, bearing dense fringe of erect, elongate setae along upper edge, as well as discrete bundles of setae along outer edge of marginal fringe (as in *C. stellata*, marginal setae appear clumped in unique type, but this likely an artefact of preservation); trichome not broadly open mesally, but with small

median fovea; posterior edge of triehome broadly elevated, with posterolateral carina extending from its outer corner to merge with apical elytral margin; elytral disc with few shallow punctures near scutellum and more faintly along suture to rear, otherwise impunctate, smooth and shining, with only minute setigerous punctures sparsely scattered throughout. Mesosternum about one-fourth as long as wide, weakly depressed on either side of midline, marginal stria fine, close to margin; mesosternal disc with numerous small punctures; mesometasternal and median metasternal sutures finely impressed; metasternal disc smooth, with sparse, setigerous punctures, each with one or more scale-like or branched setae; first visible abdominal sternite smooth, with setigerous punctures denser than those of metasternite. Profemur about 3x as wide as long, anterior and posterior edges sinuate, but more or less parallel; mesofemur shorter, with edges weakly arcuate; metafemur longer, but broader, with anterior and especially posterior margins arcuate; meso- and metafemora lacking posterior marginal stria; protibia slender, angulate about one-third from base; mesotibia slightly broader, still angulate; metatibia distinctly broader, bluntly angulate near midpoint.

Propygidium with numerous setigerous punctures near base, becoming sparser toward apex, setae branched or scale-like, ground texture smooth and shining; pygidium similar in texture, but with setigerous punctures sparser.

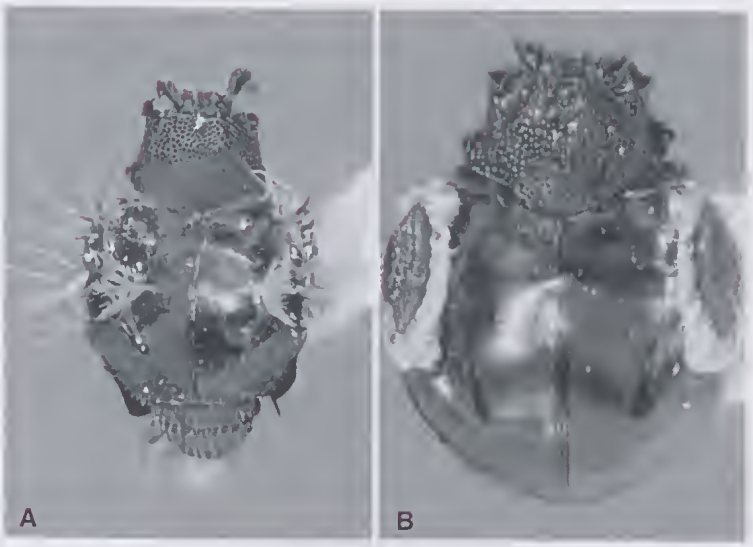


FIG. 18. Dorsal views of *Chlamydonia* spp. A, *C. erectipilosa* sp. nov. (head reattached to body digitally). B, *C. eucurtiopsoides* sp. nov.

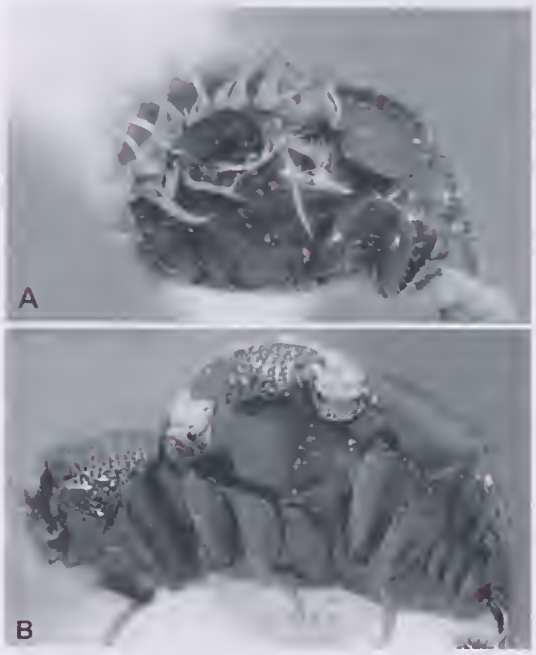


FIG. 19. Lateral views of *Chlamydonia* spp. A, *C. erectipilosa* sp. nov.; B, *C. eucurtiopsoides* sp. nov.

Chlamydonia eucurtiopsoides sp. nov.
(Figs 18B, 19B)

MATERIAL. HOLOTYPE ♀: NEW CALEDONIA 8904, 20°58'Sx165°17'E, 500m, Pic d'Amoa, N slopes, 24 Nov 2001-31 Jan 2002, G.B. Monteith, FIT trap; in MNHN.

DIAGNOSIS. This species and the following two (*C. punctinota* and *C. fauveli*) form a distinctive group, and are diagnosed here together. They can be separated from all other *Chlamydonia* by their wide, virtually impunctate elytra, with broad mediobasal depression, in combination with a short triehome setal fringe. *Chlamydonia erectipilosa*, above, also has impunctate elytra, but has a very distinctive elongate, erect trichome fringe. Diagnosing *C. eucurtiopsoides* from *C. fauveli* and *C. punctinota*

is more difficult. *Chlamydonia fauveli* is the most distinctive of these, with the setal fringe particularly extensive, due mainly to an enlarged posterior basal incision, providing a larger setose opening behind the trichome disc. The trichome disc itself is also impunctate, whereas in *C. eucurtiopsoides* and *C. punctinota*, at least the uppermost surface of the trichome disc bears numerous conspicuous punctures. *C. eucurtiopsoides* is the largest of these three species, with the elytra also broader relative to the prothorax. *Chlamydonia punctinota* is extremely similar, but aside from being slightly smaller, it is darker in color, lacks the small elytral punctures found near the scutellar region of *C. eucurtiopsoides*, and has fewer and shallower punctures on the upper surface of the trichome disc, with the punctures restricted to its upper, widest portion, whereas in *C. eucurtiopsoides*, these extend further toward the epipleuron, with a few punctures at the narrowest point (between anterior and posterior constrictions).

DESCRIPTION. L: 1.68; W: 1.50; E/Pn L: 2.00; E/Pn W: 1.92; Pn W/L: 1.39; E L/W: 0.75; Pr/Py: 1.00; Sterna: 0.56, 0.09, 0.41; Tibiae: 0.50, 0.44, 0.50. Body broad, with prothorax much narrower than elytra, dark rufescent, with impunctate areas (e.g. elytra) appearing slightly lighter, lacking conspicuous setae beyond those of humeral trichome. Frons about two-thirds as wide as long, with sides arcuate, weakly convergent to epistomal suture, with 3 pairs of prominent tubercles, uppermost pair (between antennal bases) less strongly protuberant, densely punctate between tubercles; labrum small, arcuate, with few small but deep punctures; antennal scape widest near middle, explanate at outer edges, with few small punctures, but largely impunctate, particularly along outer edge; funicle and antennal club subequal in length, each slightly over half scape length.

Prothorax widest at base, sides arcuate, narrowed to near apex, widened at antennal cavities, unmargined; median pronotal processes moderately prominent at anterior margin, weakly extended posterad; lateral pronotal processes more prominent, forming distinct carina extending from anterior margin obliquely posterolaterad behind antennal cavities, terminating before reaching lateral pronotal margin; pronotal disc densely punctate, with punctures slightly smaller and less dense mediobasally. Prosternum with anterior margin sinuate, arcuately produced beneath head, marginal stria present at sides, obsolete at middle; prosternal disc densely punctate except for narrow band of minute punctures along anterior margin and between procoxae; prosternal keel weakly depressed between coxae.

Elytra with sides very broadly rounded, widest at humeral trichomes, nearly twice as wide as base of pronotum; mediobasal depression very broad; humeral trichomes prominent; trichome disc rounded apically, suberect, extending from humeral corner posterad nearly to elytral midpoint, bearing dense golden marginal fringe; anterior and posterior basal incisions of trichome expanded on epipleuron, undercutting base of trichome disc, incisions completely fringed with dense marginal setae; mesal surface of trichome concave at base, but lacking distinct mesal fovea; elytral disc smooth and shining, impunctate except for few shallow punctures near scutellum, and with dense punctures on upper part of trichome disc, these becoming obsolete on epipleuron; epipleuron completely impunctate.

Mesosternum about one fourth as long as wide, bluntly projecting anteriorly at middle; marginal stria elevated, mesosternal disc weakly depressed and bearing small punctures behind; mesometasternal and median metasternal sutures finely impressed; metasternal disc with only sparse minute punctures. Profemur with anterior and posterior edges weakly sinuate, outer surface punctate in basal two-thirds; mesofemur shorter, about 3x as long as maximum width, anterior and posterior margins arcuate, without marginal striae; metafemur with margins more broadly arcuate, only about twice as long as maximum width; protibia slender, acutely angulate one-third from base; meso- and metatibiae broad, with outer edges flattened, both with outer margin bluntly angulate just basal to midpoint; tarsi strongly laterally compressed; tarsal claws short, weakly arcuate.

Propygidium and pygidium smooth and shining, with only minute setigerous punctures; propygidium weakly depressed along basal margin; pygidium weakly depressed along lateral margins.

REMARKS. With this species and the following known from single specimens, one of each sex, it is impossible to say how general the differences highlighted here may be. While obvious dimorphism has not been observed in *Chlamydonia* (as it has in *Chlamydopsis* and some *Eucurtiopsis*; Caterino, 2003; Dégallier & Caterino, 2005), it is conceivable that this accounts for some observed differences. It is also possible that additional sampling, particularly in intervening areas (the

type localities are separated by about 75 km), will blur these distinctions, and that their respective status will need to be reassessed.

Chlamydonia punctinota
sp. nov.
(Figs 20A, 21A, 28A)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 11486, 20°24'S × 164°32'E, Mandjelia summit, 750m. 29 Nov 2003-31 Jan 2004, G.B.Monteith, flight int. trap.; in MNHN.

DIAGNOSIS. See diagnosis under *C. eucurtiopsoides*, above.

DESCRIPTION. L: 1.59; W: 1.37; E/Pn L: 2.19; E/Pn W: 1.73; Pn W/L: 1.59; E L/W: 0.80; Pr/Py: 0.95; Sterna: 0.47, 0.09, 0.41; Tibiae: 0.47, 0.53, 0.50. This species is very similar to *C. eucurtiopsoides*, and is only described here to the extent that they differ. Smaller overall, and particularly with elytra less broadly expanded relative to prothorax; integument uniformly darker; pronotal punctation less dense, many punctures separated by their widths, with impunctate intervening areas; nposterolateral pronotal tubercles only vaguely evident; elytra lacking punctures near scutellum; humeral trichome smaller, its posterior edge (posteriormost setose margin) clearly anterior to elytral midpoint; trichome disc smaller, with punctures restricted to dorsalmost portion of lateral surface.

REMARKS. The species name refers to the punctured pronotum, in particular as it contrasts with the impunctate elytra.

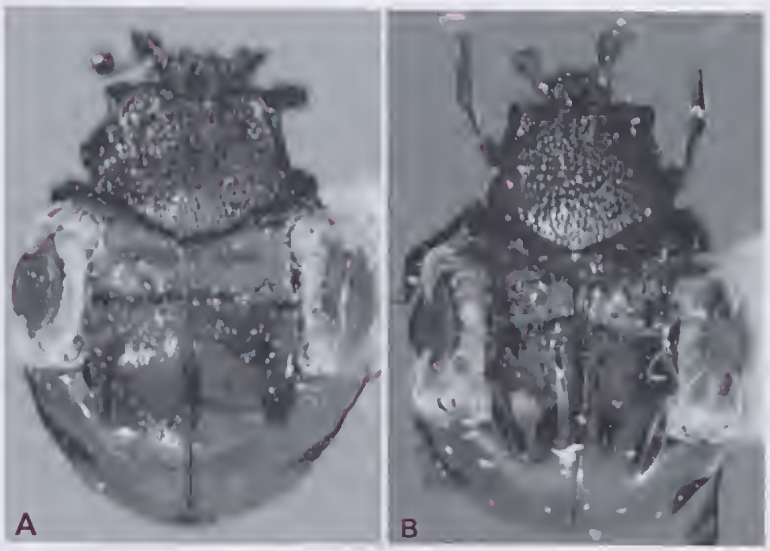


FIG. 20. Dorsal views of *Chlamydonia* spp. A, *C. punctinota* sp. nov.; B, *C. fauveli* sp. nov.

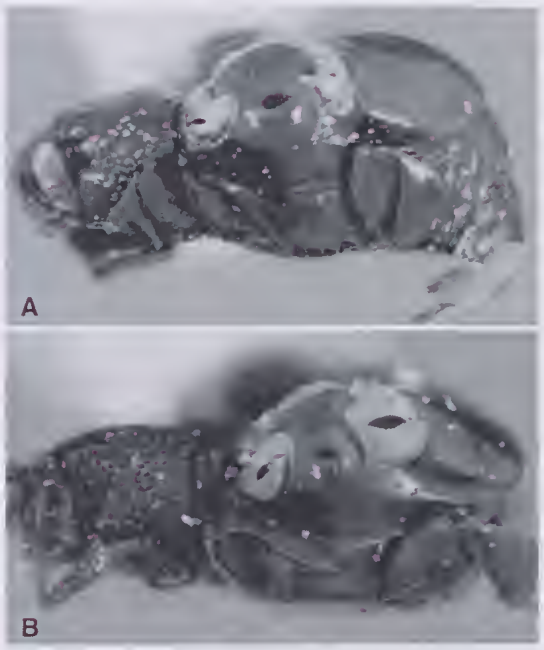


FIG. 21. Lateral views of *Chlamydonia* spp. A, *C. punctinota* sp. nov.; B, *C. fauveli* sp. nov.

Chlamydonia fauveli sp. nov.
(Figs 20B, 21B)

MATERIAL. HOLOTYPE ♀: NEW CALEDONIA, Monts Koghis, Auberge, 26.VII-13.VIII.1978, S. & J. Peck, 500m, rainforest, nr. Nouméa; dissected by A. Tishechkin; in CMN.

DIAGNOSIS. See diagnosis under *C. eucurtiopsoides*, above.

DESCRIPTION. L: 1.68; W: 1.31; E/Pn L: 2.18; E/Pn W: 1.83; Pn W/L: 1.35; E L/W: 0.88; Pr/Py: 0.90; Sterna: 0.47, 0.06, 0.41; Tibiae: 0.44, 0.47, 0.53. As for the preceding two species, differing as follows: body rufescent, as in *C. eucurtiopsoides*; frontal tubercles confusedly arranged, with series of 4 discrete tubercles on left side, with only a single epistomal tubercle and an elongate carina on the right; pronotal

processes weakly developed, median pair evident at anterior margin, diminishing as low carinae just behind margin; lateral supra-antennal alae slightly better developed, diminishing posterad to about one-third from anterior margin; elytra with humeral trichomes extending from anterior corners posterad to just beyond elytral midpoint, trichome disc rather small, nearly vertical, impunctate, bearing continuous marginal fringe; anterior and posterior basal incisions expanded, undercutting disc at base, with posterior opening, particularly, large and enfringed by dense setae; inner surface of trichome convex, only weakly depressed at base; elytra smooth and shining with only sparse, inconspicuous minute setigerous punctures over most of surface, with unique clusters of minute, raised setigerous tubercles in post scutellar area.

REMARKS. This species is named for Charles Adolphe Albert Fauvel, one of the fathers of New Caledonian coleopterology.

Chlamydonia terapoides sp. nov.
(Figs 8A, 22A, 23A, 28D)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 8904, 20°58'S × 165°17'E, 500m, Pic d'Amoa, N slopes, 24 Nov 2001-31 Jan 2002, G.B. Monteith, FIT trap; in MNHN. PARATYPES (9♂♂): 7: same data as holotype; 2: NEW CALEDONIA 11482, 20°58'S, 165°17'E, 500m, Pic d'Amoa, N slopes. 27 Nov 2003 - 30 Jan 2004. G.B. Monteith, flight int. trap.; in QM and MSCC.

DIAGNOSIS. This species is the first of a group, comprising the remaining species of *Chlamydonia*, quite distinct from those above. In all members of this group, the rounded, variously elevated trichome disc described above represents a less prominent part of the overall trichome configuration. In most it is reduced in size, oriented nearly horizontally, and is set off from the epipleuron by a lateral ridge. In all species the anterior and posterior transverse incisions at the base of this disc are closed laterally, not extending to the epipleuron. The posterior incision, in addition, is opened up to form a shallow angulation, bearing the most conspicuous setal fringe. This is also extended in most by a posterior carina. *Chlamydonia terapoides* is the only species in the group in which this disc exhibits a setal fringe along its entire margin. In all of the remainder the setal fringe is absent from most of the anterior half of the reduced disc, and is restricted to the posterior angulation (and a small, separate anterolateral whorl). The two epipleural pits (beneath the trichome angulation) are unique to *C. terapoides*. *Chlamydonia angulata* exhibits a single larger pit in this position, but no such pits are seen in any other species. Also, as its name suggests, the meso- and metatibiae of this species are unusually large (shared to a lesser degree by *C. sinuata*).

DESCRIPTION. L: 1.53; W: 1.09; E/Pn L: 1.97; E/Pn W: 1.40; Pn W/L: 1.52; E L/W: 0.93; Pr/Py: 0.94; Sterna: 0.53, 0.09, 0.41; Tibiae: 0.50, 0.62, 0.69. Body form elongate, subquadrate, bronzy rufescent brown, almost entirely glabrous. Frons nearly twice as long as wide, sides more or less narrowed to front, their outlines interrupted where incised by antennal insertions; frontal disc with irregular series of (2-3) small tubercles mesal to antennal bases and with more conspicuous pair of tubercles at sides nearer anterior margin; frontal disc with irregularly spaced deep, ovoid punctures and fine intervening rugose microsculpture; labrum approximately semicircular, densely covered with very small punctures, with few inconspicuous setae along anterior margin. Antennal scape with narrow base, with inner margin sinuate, outer margin bluntly angulate near middle; disc of scape weakly explanate along outer edge, more convex along median axis, its surface with similar punctation and microsculpture to frons.

Prothorax about two-thirds as long as wide, unmargined laterally (in some individuals raised edges of punctures align to form a pseudomargin); sides inwardly arcuate, slightly narrower at apex than at base; antennal cavities broadly exposed from above; anteromedial pronotal margin shallowly inwardly arcuate; pronotal disc with low, paired longitudinal ridges diminishing from anterior margin to just beyond middle; oblique alae extending from anterior margin (actually projecting slightly beyond it) posterolaterally nearly to lateral pronotal edge; disc uniformly covered with deep ovoid punctures, these aligned mainly longitudinally, though converging antero- and posteromedially. Prosternum with anterior margin bisinuate, outwardly arcuate at middle, disc shallowly depressed behind anterior margin, narrowing posteriorly between procoxae, shallowly emarginate at posterior apex, with striae delimiting leg depressions elevated, carinate.

Elytra with sides faintly sinuate, broadest just behind humeri, narrowed strongly to base, and gradually to apex; humeral trichome conspicuous, comprising mainly an elongate, angulate carina, extending in a shallow arc

from very near anterolateral elytral corner posteriorly to about one-third from base, bending obliquely mesad, extending thence nearly to longitudinal elytral midpoint; this carina with dense fringe of mesally directed setae along almost entire length, extending fully to base where it loops around, nearly enclosing a very small opening, ending posteriorly just before terminus of carina; short, blunter, nearly parallel carina present beneath middle of anterior portion of trichome, forming a small 'shelf'; elytra with distinct mediobasal depression in basal one-third, extending laterad to form excavation beneath trichome; anterolateral corner of elytral dorsum delimited laterally by an arcuate supraepipleural carina; elytral disc densely punctate, punctures fewer only within outer half of mediobasal depression; pair of deep pits present beneath trichome on upper epipleural surface, above highest point of accessory stria; epipleuron otherwise uniformly punctate, only slightly less densely so within accessory epipleural stria; extreme elytral margin broad and with conspicuous polygonal microsculpture beneath epipleuron.

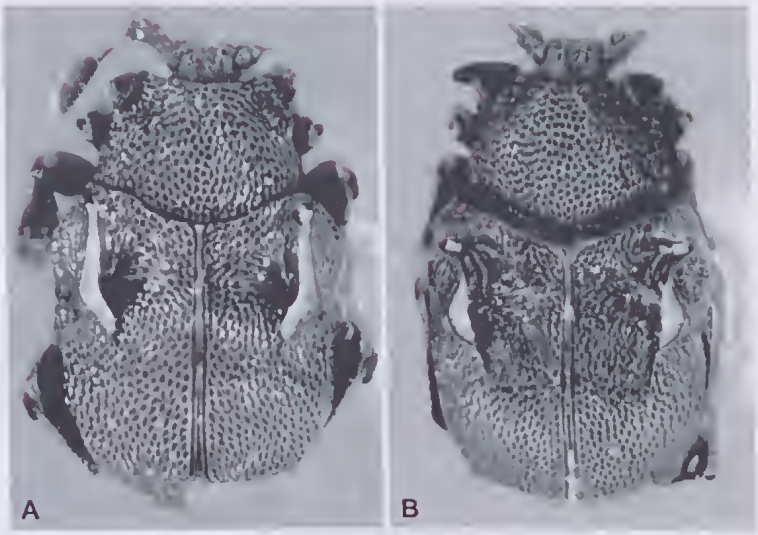


FIG. 22. Dorsal views of *Chlamydonia* spp. A, *C. terapoides*. B, *C. sinuata*.

Mesosternum broad, bluntly projecting at middle, depressed on either side of midline, appearing faintly tuberculate at middle in some individuals; mesosternal disc densely punctate except at extreme sides; mesometasternal and median metasternal striae finely but deeply impressed; metasternal disc densely and uniformly punctate (as in both mesosternum and 1st abdominal ventrite). Pro-, meso-, and metafemora with outer surfaces uniformly punctate in basal 5/6 (the profemur most coarsely so), with apices impunctate; protibia narrow, with outer margin angulate just before middle, densely punctate along outer half, coarsely microsculptured along inner edge; meso- and metatibiae enlarged broader, with outer margins broadly rounded, only faintly angulate about 2/3 from base, outer surfaces shallowly punctate, with conspicuous polygonal microsculpture throughout.

Propygidium and pygidium uniformly densely punctate; propygidium narrowly depressed along basal margin, elsewhere weakly convex; pygidium convex, elevated mainly along midline, with a few fine setae intermingled with punctures toward apex.

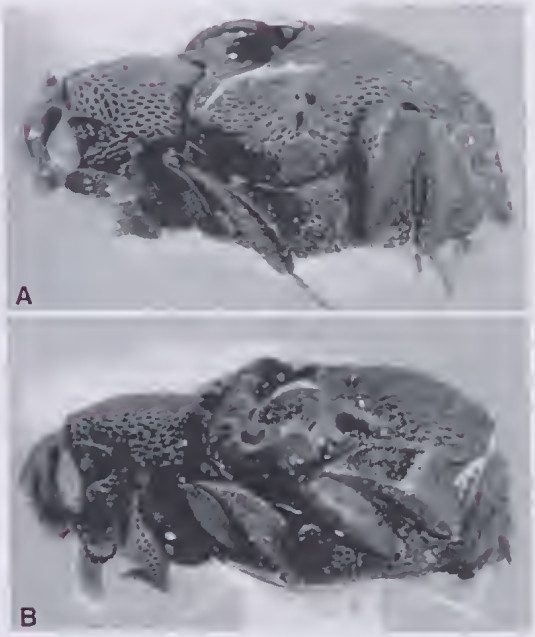


FIG. 23. Lateral views of *Chlamydonia* spp. A, *C. terapoides sp. nov.*; B, *C. sinuata sp. nov.*

REMARKS. The specific name of this species refers to its enlarged posterior tibiae, reminiscent of those of the New World hetaeriine histerid, *Terapus*.

Chlamydonia sinuata sp. nov.
(Figs 8B–D, 22B, 23B, 28C)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 11476, 21°35'S × 165°48'E, 400m. Col d'Amieu, sawmill. 25 Nov 2003-27 Jan 2004, G.B. Monteith, flight int. trap.; in MNHN. PARATYPES (13♂♂), 9: same data as holotype; 2: NEW CALEDONIA 11475, 21°37'S, 165°49'E, Col d'Amieu, west slope. 25 Nov 2003-27 Jan 2004,G.B. Monteith, flight int. trap.; 2: NEW CALEDONIA 8910, 22°21'S, 166°58'E, Port Boise (G.Kanua), 22 Nov 2001 - 29 Jan 2002, G.B. Monteith, FIT trap; in QM and MSCC.

DIAGNOSIS. In addition to the group diagnosis above, this species is further distinguished by the very strongly sinuate inner edge of the trichome. Its marginal setae are restricted to the posterior half of the anterior disc, extending around the arcuate posterior angulation. The inner edge of the trichome is not prolonged by a posterior carina. The anteromedian 'shelf' beneath the trichome is particularly prominent, and separated from the anterior disc by a deep groove.

DESCRIPTION. L: 1.37; W: 1.00; E/Pn L: 1.93; E/Pn W: 1.39; Pn W/L: 1.53; E L/W: 0.91; Pr/Py: 1.00; Sterna: 0.45, 0.06, 0.37; Tibiae: 0.44, 0.56, 0.59. Body dark rufescent brown, elongate subquadrate, dorsum nearly uniformly densely punctate, punctures becoming transversely strigose in mediobasal elytral depression. Frons with two discrete tubercles near anterior margin, with poorly developed, somewhat oblique, elongate elevations anteromesal to antennal insertions, somewhat depressed between and above these; frontal disc uniformly densely punctate except granulate at antennal insertions; labrum approximately semicircular, weakly angulate at apex, surface granulate, with few faintly impressed punctures; antennal scape with outer margin bluntly angulate just beyond middle, surface with sparse, shallow punctures, but with dense granulate microsculpture throughout; antennal club of male equal in length to scape; female not known.

Pronotum transverse, slightly wider at base than apex, sides unmargined, weakly inwardly arcuate; anterior margin with very weakly developed tubercle on either side, separated by about one half frontal width, and low, oblique lateral flange extending from above inner corner of antennal cavity posterolaterally about halfway to lateral pronotal margin; pronotal disc densely covered with slightly oblong punctures, separated by about one-fourth their widths. Prosternum densely punctate except at extreme sides in front of procoxal depressions, short in front of these depressions, about one half length of depression behind; prosternal disc broadly depressed behind anterior margin, narrowed, slightly depressed between coxae; prosternal keel emarginate at base, with marginal stria continuous around all edges.

Elytra with broad mediobasal depression in basal one-third; humeral trichome prominent, complex, composed primarily of a longitudinally oriented, sinuate groove, with two separate setiferous areas, one near anterolateral elytral corner small, ovoid, mesally open, completely encircled by setae, one situated posterad, about one-third from elytral base, comprising an elongate, open arc, with golden fringe of convergent, mesally directed setae; setose areas connected by a broad deep groove, laterad of which is a ovoid, shallowly concave plateau (corresponding to the 'disc' described in species above), about 2x width of groove itself, and mesad of which is a more or less triangular, convex, vertically oriented sclerite closing off mediobasal elytral depression anteriorly; elytral disc densely, uniformly punctate, except within mediobasal depression, where punctures are transversely elongated, converging beneath trichome, and on epipleuron, which is entirely impunctate apart from: a few minute punctures within the accessory epipleural stria, faint alutaceous microsculpture beneath central portion of dorsal trichome, and faint polygonal microsculpture between accessory epipleural stria and lateral elytral margin. Each elytron with fine marginal stria complete on all edges.

Mesosternum short, broad, with bluntly acute anteromedial projection; mesosternal disc depressed on either side of midline, densely punctate except at extreme sides; mesometasternal and median metasternal striae finely impressed; metasternal disc less densely punctured than either mesosternum or 1st abdominal ventrite, with punctures separated by their widths or more; 1st abdominal ventrite with postmetacoxal stria obsolete at middle, visible behind coxae. Profemur punctate in basal half, becoming smoother, with fine polygonal microsculpture apically; meso- and metafemora almost entirely impunctate, faintly rugose near bases, otherwise with fine microsculpture, and very minute setae, throughout; protibia short, narrow, with outer margin angulate one-third from base; meso- and metatibiae broader, with outer margins rounded, with conspicuous polygonal microsculpture near inner and outer margins and fine setiferous punctures throughout.

Propygidium somewhat depressed, and with round punctures, along basal margin, becoming convex, and with punctures more elongate and sparse apicad; pygidium nearly flat, slightly elevated along midline, with punctures smaller and slightly sparser than on propygidium.

Chlamydonia dzumacensis
sp. nov.
(Figs 24A, 25A)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 8934, 22°03'S × 166°28'E, Mt Dzumac road, 700m, 1 Nov 2001-27 Feb 2002, G.B. Monteith FIT trap; in MNHN. PARATYPES (2♂♂): 1: same data as holotype; 1: NEW CALEDONIA 11467, 22°03'S, 166°28'E, Dzumac Road, 700m. 5 Dec 2003 - 26 Jan 2004. G.B. Monteith, flight int. trap.; in QM.

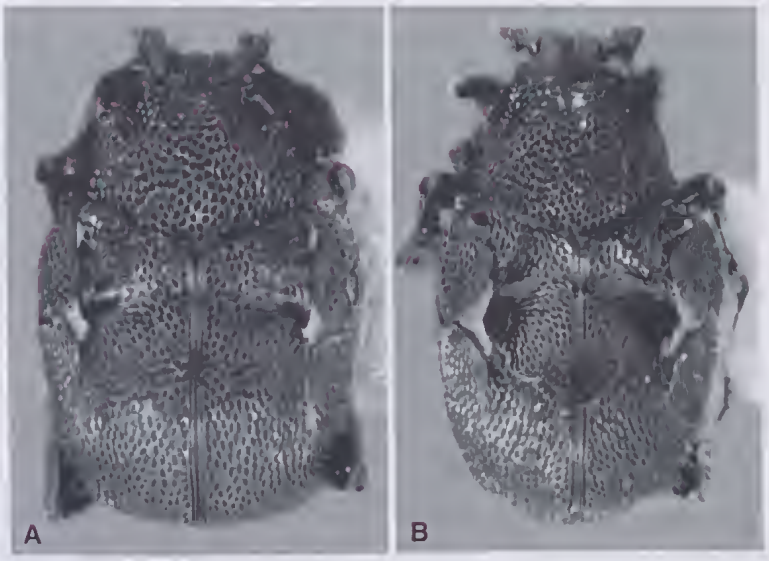


FIG. 24. Dorsal views of *Chlamydonia* spp. A, *C. dzumacensis* sp. nov.; B, *C. volans* sp. nov.

DIAGNOSIS. This species, while very similar to its close relatives *C. volans* and *C. angulata*, is fairly easily distinguished by trichome morphology. The posterior angulation is relatively shallow (about 120°), bears a small setal fringe, and is extended posteriorly by a bare longitudinal carina extending to about two-thirds of the total elytral length. The epipleuron bears a fine but distinct pit beneath the outer corner of the trichome angulation. In *C. angulata* this pit is larger, and in *C. volans* it is absent (and in the otherwise dissimilar *C. terapoides* there are two). *Chlamydonia dzumacensis* is further distinguished from *C. angulata* and *C. volans* by the uniform epipleural punctation, even within the accessory stria, where in these other two species there are only fine, or no obvious punctures.

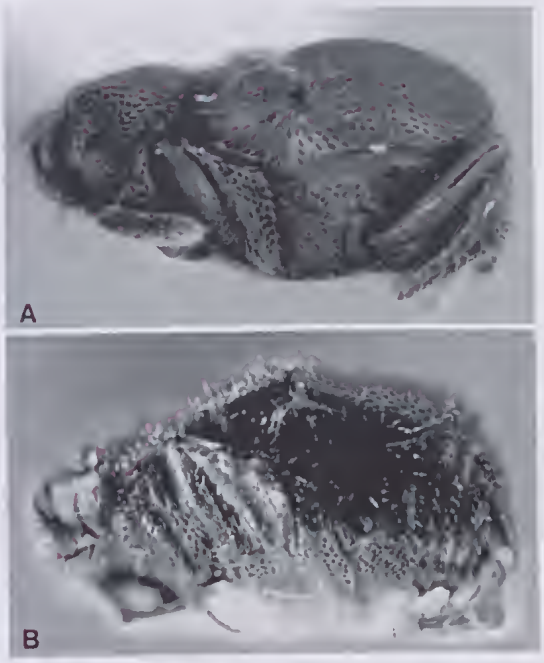


FIG. 25. Lateral views of *Chlamydonia* spp. A, *C. dzumacensis* sp. nov.; B, *C. volans* sp. nov.

DESCRIPTION. L: 1.44; W: 1.01; E/Pn L: 1.88; E/Pn W: 1.41; Pn W/L: 1.44; E L/W: 0.92; Pr/Py: 0.89; Sterna: 0.50, 0.08, 0.41; Tibiae: 0.59, 0.62, 0.66. Body elongate, subquadrate, faintly bronzy; all dorsal surfaces densely punctate, with very sparse, fine setae interspersed. Frons about 1.5x as long as wide, sides weakly arcuate, narrowed anteriorly and abruptly interrupted at antennal insertions; frons with paired, weakly developed longitudinal rows of tubercles, some coalescing into weak carinae, from antennal base to epistomal suture on each side; frontal disc densely punctate, with few very fine setae; antennal scapes more or less flat, not obviously explanate laterally, with outer margins bluntly angulate just beyond middle, punctures of scape slightly less deeply impressed than those of frons, with more flat surface appearing between;

scape with very fine setae, particularly along outer margin.

Prothorax about 1.5x as wide as long; sides unmargined, inwardly arcuate, widest at base, narrowed abruptly from base, then gradually widened to apex; antennal cavities completely exposed from above; pronotum with low, paired, oblique alae extending posterolaterally from anterior margin, diminishing behind middle of antennal cavity; mesal to these an additional pair of very poorly developed longitudinal carinae extend from anterior margin posteriorly nearly to pronotal midpoint; posterior half of pronotum evenly convex, densely covered with deep ovoid punctures, which converge to posterior midpoint. Prosternum with anterior margin bisinuate, outwardly arcuate at middle, disc shallowly depressed behind anterior margin, narrowing posteriorly between procoxae, shallowly emarginate at posterior apex, with striae delimiting leg depressions elevated, carinate.

Elytra broadest just behind anterior corners, slightly and evenly tapered to apex; mediobasal depression relatively small, confined to about basal one-fifth; humeral trichome comprising mainly a sinuate, longitudinal carina, extending from very near anterolateral elytral corner about two-thirds length of each elytron; this carina inwardly arcuate in basal half, outwardly angulate at middle, and more or less straight in apical half, with prominent mesally directed setal fringe within median angulation, and smaller, separate fringe at its very base (in anterolateral corner); a shallow, impunctate groove extends beneath inner edge of carina for its entire length; mediobasal elytral depression extending laterally beneath trichome; lateral edge of anterior trichome disc delimited by weak arcuate carina which extends from near anterior corner to outer apex of trichome angulation; epipleuron with single deep (though narrow) pit between apex of preceding carina and anterodorsal apex of accessory epipleural stria; epipleuron uniformly punctate, more sparsely than dorsum, with ovoid punctures converging to trichome; epipleural margin broad, with polygonal microsculpture; marginal elytral stria complete on all edges; elytral disc uniformly densely punctate, with fine inconspicuous interspersed setae.

Mesosternum short, broad, bluntly projecting at middle, depressed on either side of midline; mesosternal disc densely punctate except at extreme sides; mesometasternal and median metasternal striae finely impressed; metasternal disc similarly densely punctate; disc of first abdominal ventrite flat, broad, somewhat extended laterally by an acute lateral projection beneath metatrochanter; postmetacoxal stria obsolete along anterior margin of 1st abdominal ventrite, present from posteromedial corner of metacoxa to posterior margin of ventrite, merging with margin. Profemur with small punctures throughout; meso- and metafemora with small punctures in no more than basal one-third, with only minute setiferous punctures to apex; all tibiae narrow, outer margins explanate, angulate one-third from base.

Propygidium and pygidium uniformly densely punctate, with fine interspersed setae; propygidium flat basally, convex in apical half; pygidium evenly convex.

REMARKS. One specimen collected in the same sample with the holotype differs subtly in a couple of respects, and is excluded from the type series. In particular, the posterior angulation of the trichome is deep, nearly 90°, and bears a more elongate and conspicuous median fringe. The epipleural pit on the outside of this angulation is also considerably larger. In these respects it is similar to *C. angulata*.

Chlamydonia volans sp. nov.
(Fig. 24B, 25B)

MATERIAL. HOLOTYPE ♀: NEW CALEDONIA 8904, 20°58'S × 165°17'E, 500m, Pic d'Amoa, N slopes, 24 Nov 2001 - 31 Jan 2002, G.B. Monteith, FIT trap; in MNHN. PARATYPES (4♀♀): 1: same data as holotype; 1: NEW CALEDONIA 11482, 20°58'S, 165°17'E, 500m, Pic d'Amoa, N slopes. 27 Nov 2003 - 30 Jan 2004. G.B.Monteith, flight int. trap.; 2: NEW CALEDONIA 11486, 20°24'S, 164°32'E, Mandjèlia summit, 750m. 29 Nov 2003 - 31 Jan 2004, G.B. Monteith, flight int. trap.; in QM and MSCC.

DIAGNOSIS. This species is very similar to the preceding and the following (*C. angulata*) by virtue of the angulate humeral trichomes. It is distinct in having these more deeply (laterally) angulate, more strongly elevated, and in having the longitudinal carina extending posterad from the inner apex of the trichome poorly developed, extending posteriorly for a distance less than that of the setose portion of the trichome itself. This species also has the epipleuron more finely and sparsely punctate, and bears conspicuous elongate setae on the elytral dorsum, as well as most other body surfaces.

DESCRIPTION. L: 1.40; W: 0.95; E/Pn L: 2.00; E/Pn W: 1.42; Pn W/L: 1.43; E L/W: 0.98; Pr/Py: 0.89; Stema: 0.44, 0.08, 0.34; Tibiae: 0.45, 0.53, 0.58. Body elongate, almost parallel sided, prothorax slightly narrower than elytra, densely punctate throughout. Frons slightly longer than wide, sides weakly arcuate, incised at antennal bases, narrowed anteriorly, with parallel, longitudinal rows of irregular, blunt tubercles, forming indistinct ridges partially obscured by dense punctation, with smaller setigerous punctures concentrated subserially along these ridges; labrum flat, semicircular, finely punctatorugose, with few setae; antennal scape subtriangular, with inner edge weakly inwardly arcuate, flat basally, more convex in apical half, with apical angle bluntly rounded, disc shallowly but densely punctate throughout, with conspicuous elongate, apically curved setae; antennal funicle and club (of female) about one-half, and two-thirds length of scape, respectively.

Prothorax about 1.3x as wide as long, sides unmargined, faintly sinuately narrowed anteriorly; antennal cavities visible from above, with anterolateral portion of pronotal margin obliquely elevated above; medial portion of pronotal margin unelevated, shallowly emarginate; pronotal dorsum strongly convex, with posteromedial swelling diverging into separate low carinae extending to anterior pronotal margin, densely and deeply punctate throughout, with sparse, elongate setae throughout, particularly along anterior margin. Prosternum with anterior margin broadly outwardly arcuate, lacking marginal stria; prosternal disc shallowly transversely depressed behind anterior margin, keel elevated between procoxae (though slightly depressed along midline), narrowed posteriorly, emarginate at apex, disc densely punctate at middle, only slightly less so at extreme sides.

Elytra with sides straight, widest near base, converging slightly to apex; humeral trichome prominent, elevated, longitudinally oriented, with inner edge sinuately extending posteromedially from humeral corner, recurving laterally, then angulate near lateral edge and curving posteromedially again, terminating in a short, low, longitudinal carina; trichome with setae only in basal humeral depression, and within posterior angulation (about one-third from base); trichome broadly excavate beneath setose angulation; longitudinal humeral carina delimiting dorsal arc of anterior trichome disc, this curving inward slightly to trichome angulation, interrupted by a short, shallow, vertical incision beneath angulation, thence continued posteriorly for a short distance, diminished beyond elytral midpoint; dorsum of elytral disc densely and deeply punctate, transversely rugose within mediobasal depression, rugae convergent to trichome, with sparse, but elongate, apically curved setae throughout; epipleuron finely punctate beneath humeral carina anteriorly, and within accessory epipleural stria posteriorly; marginal epipleural stria deeply impressed, continuous with nearly complete marginal elytral stria (interrupted only in front of humeral trichome).

Mesosternum wide, short, transversely depressed with only lateral and anterior margins finely elevated, bluntly projecting at middle; mesometasternal and median metasternal sutures finely impressed, postmesocoxal lines prominent, extending across metepisternum (slightly interrupted at sternal-episternal suture), enclosing largely impunctate depression; metasternal disc otherwise densely punctate; first visible abdominal sternite similarly punctate, with postmetacoxal line originating medial to metacoxa, extended directly posteriorly nearly to edge of sternite, curving laterad, terminating freely just before reaching epipleuron. Femora with dense punctures in basal half, becoming impunctate toward apex; tibiae with outer margins bluntly angulate, protibia just before midpoint, meso- and metatibiae just beyond, width at widest point about one-third tibial length; tibiae longitudinally convex along inner edge, slightly explanate along outer edge; tarsi weakly compressed laterally; tarsomeres bearing elongate setae on dorsal and ventral surfaces.

Propygidium twice as wide as midline length, slightly depressed along basal margin, otherwise weakly convex; pygidium nearly as long as wide, very weakly convex; both deeplyand uniformly punctate.

REMARKS. This species name highlights the fact that all of the female types were collected by flight interception traps.

Chlamydonia angulata sp. nov.
(Fig. 26A, 27A)

MATERIAL. HOLOTYPE probably ♀: NEW CALEDONIA 11509, 21°25'S × 165°28'E, 400m. Col des Roussettes. 2 Feb 2004. G.B. Monteith, pyrethrum trees & logs.; in MNHN. PARATYPE ♂: NEW CALEDONIA 11865, 22°14'S, 166°50'E,

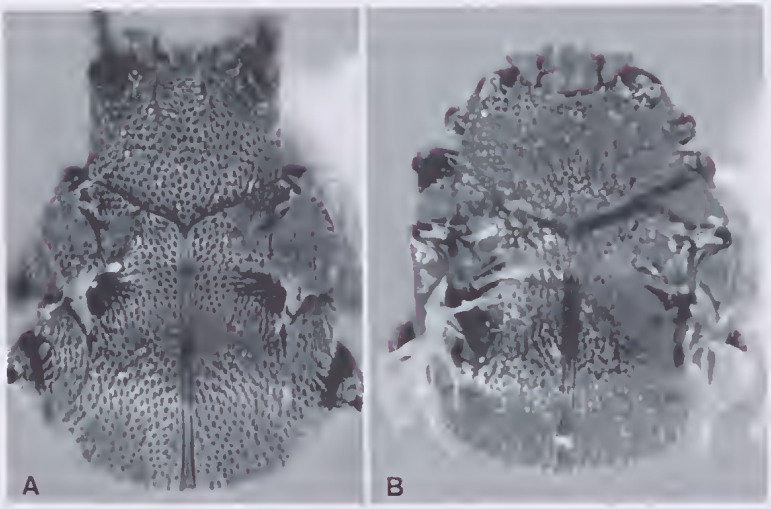


FIG. 26. Dorsal views of *Chlamydonia* spp. A, *C. angulata* sp. nov.; B, *C. wenzeli* sp. nov.

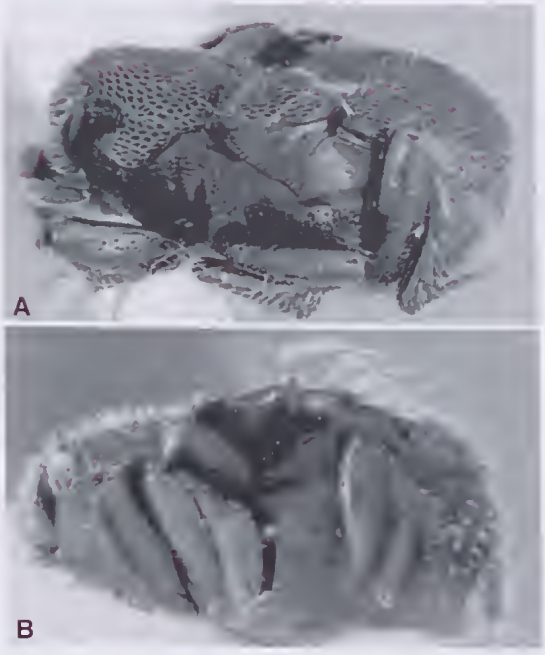


FIG. 27. Lateral views of *Chlamydonia* spp. A, *C. angulata* sp. nov.; B, *C. wenzeli* sp. nov.

280m, Pic du Pin, site 2. intercepts, 25 Nov 2004 - 12 Jan 2005, G.B. Monteith, Grimbacher, RF; in QM.

DIAGNOSIS. This species is quite similar to the preceding two. All share the distinctly angulate trichome, with its fringe restricted to this angulation. In *C. angulata* and *C. dzumacensis* this angulation is continued posterad by a long carina, which is poorly developed in *C. volans*. The elytra are broader relative to the prothorax in *C. angulata* than in either of the preceding species. The lateral sclerotised portions of its trichome, the anterior disc, and the posterior elevation, are also broader, the inner edge of the former reaching nearly the midline of each elytron. On the epipleuron, beneath the posterior trichome angulation, both *C. angulata* and *C. volans* have a vertical groove. However, in the present species, this groove is much deeper, appearing as a distinct constriction between the anterior disc and the quadrate posterior elevation. This is very shallow and superficial in *C. volans*.

DESCRIPTION. L: 1.54; W: 1.12; E/Pn L: 1.91; E/Pn W: 1.50; Pn W/L: 1.41; E L/W: 0.90; Pr/Py: 0.79; Sterna: 0.53, 0.08, 0.41; Tibiae: 0.56, 0.67, 0.75. As for *C. volans* except as follows: Elytra about one-third wider than base of prothorax; body setae more conspicuous, most of them 2-branched; anterior disc of elytral trichome flat, more nearly horizontal, elevated about 30°, relatively broad, its inner margin extended inward nearly to each elytron's midline, delimited posteriorly on its lateral edge by a deep vertical groove, which forms with posterior trichome angulation a narrow constriction; trichome fringe interrupted at outermost point of posterior angulation; epipleuron with small punctures along anterior third of lower margin, a few extending up along anterior edge of accessory epipleural stria toward trichome angulation; within accessory stria with only very small punctures, each bearing minute scale-like seta; legs, particularly those of meso- and metathorax, enlarged, femora nearly cylindrical in cross section, larger than corresponding thoracic depressions and not fully retractable; meso- and metafemora with short, mostly branched setae; outer margin of protibia strongly, subacuminately angulate just basal of midpoint; meso- and metatibiae long, relatively

slender, outer margins bluntly angulate near their midpoints, both with conspicuous elongate setae, many of them, particularly along the inner margin, branched.

REMARKS. This species is the only *Chlamydonia* described in this paper for which both sexes are known.

Chlamydonia wenzeli sp. nov.
(Fig. 26B, 27B)

MATERIAL. HOLOTYPE ♂: NEW CALEDONIA 11475, 21°37'S × 165°49'E, 470m, Col d'Amieu, west slope. 25 Nov 2003 - 27 Jan 2004, G.B. Monteith, flight int. trap.; in MNHN. Paratype (1): NEW-CALEDONIA, Mont Rembai 21.6°S, 165.85°E, 19-21 Jan 1977, leg. Dr J. BALOGH; in HNHM.

DIAGNOSIS. While sharing some characters with several of the above species, this is among the most distinctive *Chlamydonia* species. It is easily recognised by several features, most distinctively by the prominent carina extended posterad from the posterior trichome angulation bearing very elongate setal fringes on both its inner and outer edges. The body of this species is also relatively flattened compared to most of those above. Its pronotum is vaguely margined behind the antennal cavities, and completely lacks anteromedial processes.

DESCRIPTION. L: 1.70; W: 1.40; E/Pn L: 2.11; E/Pn W: 1.41; Pn W/L: 1.83; E L/W: 0.82; Pr/Py: 0.95; Sterna: 0.58, 0.08, 0.45; Tibiae: 0.59, 0.69, 0.70. Body subdepressed, not very strongly convex above, dark rufescent, with vaguely metallic sheen, most of upper surface densely punctate, with sparse but fairly conspicuous setae (aside from extremely conspicuous ones of trichome fringe); frons about one-third longer than wide, sides arcuate beneath weak indentations at antennal insertions, with single pair of small tubercles above epistomal suture; frontal disc densely punctate and bearing numerous long setae; labrum subtriangular, with few punctures, and polygonal ground microsculpture; antennal scape arcuate, bluntly angulate at middle of outer margin, shallowly punctate, faintly microsculptured; antennal funicle (of male) about two-thirds length of scape, the club about one-third longer than scape.

Prothorax weakly convex above, short, nearly twice as wide as midline length, sides slightly narrowed to front, weakly sinuate behind antennal cavities, submargined in anterior half; pronotum lacking anteromedial processes, and with only weak lateral alae above inner edge of antennal cavities; pronotal disc uniformly densely punctate, with sparse but conspicuous setae. Prosternum with anterior margin sinuate, with complete marginal stria; prosternal keel rather broad, shallowly emarginate posteriorly, with its marginal stria not following keel edges between coxae, rather more narrowly convergent; prosternal disc shallowly and sparsely punctate at middle, becoming impunctate toward sternopleural suture and at apex of keel.

Elytra broadest just behind humeri, rather evenly narrowed to apex, with mediobasal depressions weak at middle, more deeply depressed at sides; humeral trichomes prominent, with anterobasal emargination elevated, slightly removed from humeral corner, with distinct inner fringe of setae; fine groove delimiting small, semicircular anterior disc, its edge continuing through shallow posterior angulation, extended posteriorly to near elytral apex as a prominent, fairly broad carina; trichome setal fringe very elongate, erect, inserted from just behind innermost point of anterior disc, through posterior angulation, along entire posterior carina, splitting into distinct series on both its inner and outer edges; (these setal fringes appear separated into 'clumps' in holotype, as in several species above; I suspect this is a preservation artefact, as the setal insertions form a continuous series); elytral disc uniformly densely punctate, except impunctate along entire inner edge of trichome, and somewhat more broadly within the mediobasal depression, with sparse conspicuous setae throughout; epipleuron completely impunctate, within accessory stria and above.

Mesosternum short, about 6x as wide as median length, weakly produced at middle, with fine marginal stria; mesosternal disc not depressed, with only fine setigerous punctures; mesometasternal suture deeply impressed, the median metasternal and postmesocoxal less so; metasternal disc weakly convex, impunctate, smooth and shining, with sparse, minute setae; first visible abdominal sternite similar in texture to metasternum. Profemur flattened on its lower (posterior) surface, with anterior and posterior marginal striae, with few small punctures; protibia bluntly angulate about one-third from base, with marginal stria only apical to angulation, mostly smooth, with few small punctures; meso- and metafemora similar, nearly parallel-sided, with anterior and posterior margins faintly arcuate,

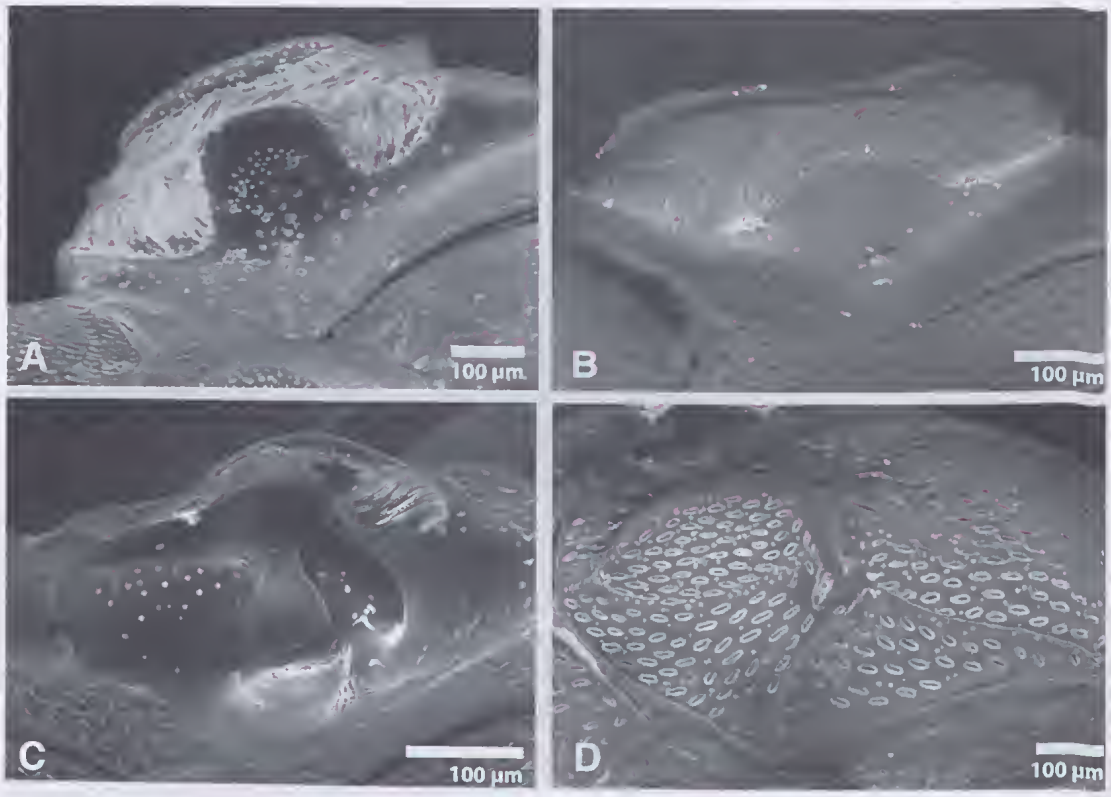


FIG. 28. Various characters of *Chlamydonia*. A, *Chlamydonia punctinota* (median fovea absent). B, *C. gomyi* sp. nov. (median fovea small). C, *C. sinuata* sp. nov. (median fovea large). D. *Chlamydonia terapoides* sp. nov. (epipleural pits present).

with marginal striae on both edges, impunctate but with conspicuous setae on ventral surface, and especially along anterior margins; meso- and metatibiae broadened, flat, outer margins bluntly angulate near midpoint, like protibia with marginal stria only along apical edge; tarsi weakly laterally compressed, with elongate setae ventrally, much shorter ones dorsally from apices of tarsomeres 1-4.

Propygidium uniformly, but rather sparsely punctate, with moderate shallow punctures separated by about twice their widths; pygidium with similar density of shallower punctures; both conspicuously setose.

REMARKS. This species is named in honor of Dr Rupert Wenzel, renowned histerid expert, in recognition of his pioneering studies of New Caledonian Histeridae.

PHYLOGENETIC ANALYSIS

TAXA. The purpose this analysis is to provide a preliminary hypothesis of relationships among the species of *Chlamydonia* described above. Outgroup relationships, and position of this genus among Chlamydopsinae, are being addressed elsewhere (Caterino & Dégallier, unpublished), and outgroup choice is based on those results. *Chlamydonia* appears to be sister lineage to the widespread '*Orectoscelis* lineage', and we include one member of this group, *Pheidoliphila magna* Caterino & Dégallier. Also included are: the single representative of *Kanakopsis*, described above, which appears to be sister to the group comprising *Chlamydonia* and the *Orectoscelis* lineage; the lone species of an as yet undescribed (New Guinean) genus which appears intermediate between that large lineage and *Chlamydopsis*; and two divergent species of *Chlamydopsis*, *C. striatipennis* Lea and *C. caledoniae*, described above.

The data matrix (see Tables 1, 2) was analysed in PAUP* (4.0b10; Swofford, 2003). All characters were unordered. Tree bisection-reconnection branch swapping was performed on 1000 random starting trees. The strict consensus tree from this search was input to TreeRot (ver. 2; Sorenson, 1999) to construct a command file for the calculation of decay indices (Bremer, 1994). MacClade (ver. 4.06; Maddison & Maddison, 2003) was used to investigate specific character support for various branches.

RESULTS AND DISCUSSION

Phylogenetic analyses resulted in 24 trees of 73 steps in length (CI = 0.5753; RI = 0.7182). The strict consensus of these (Fig. 29) is relatively well resolved, though few branches exhibit more than modest decay support. At the base of the tree this analysis suggests a slightly different resolution among outgroups than that found in a more comprehensive study (Caterino & Dégallier, unpublished). This, however, almost certainly results from sparse representation among outgroups, which are more variable in some characters than few representatives can capture. *Chlamydonia* itself is supported as monophyletic, with three steps decay support. The unambiguous changes on this branch are the defining characters of the genus: the possession of paired frontal tubercles, the presence of an accessory epipleural stria, and the uniquely reduced, but not completely hidden scutellum. This tree also reconstructs the loss of an anterior superficial trichome groove as a synapomorphy of this group, although this is also lost in numerous outgroups not included here, so is not unique to *Chlamydonia*.

Chlamydonia is split into two major lineages, both supported by a single decay step. Clade 'A' is supported by the appearance of a large median trichome fovea. A small fovea appears (from the plesiomorphic 'absent') in clade 'B'. While there is no a priori reason to exclude such a scenario, ordering this character such that a small fovea is intermediate between the absent and large states, was explored as a reasonable option. A search enforcing this ordering results in the disappearance of clade 'B' (not shown), which becomes paraphyletic with respect to a similarly resolved clade 'A'. One initially distinctive character state was the expansion of the anterior and posterior incisions of the trichome disc such that the disc is variably undercut by the trichome fringe on the epipleural surface. This is not resolved as a synapomorphy here, but is reconstructed as the basal state for *Chlamydonia*, then lost on the branch between *C. tjibaoui* and the remainder of clade 'A', the trichome becoming thus simplified. While, again, there is no legitimate reason to exclude this possibility, it is somewhat surprising. Moving *C. tjibaoui* to the base of clade 'B' (essentially rooting the ingroup tree at a different point), treating this character as irreversible, results in a tree one step longer.

One somewhat unsettling point to highlight is that only one of the *Chlamydonia* described here is represented by both sexes (*C. angulata*). Given the remarkable sexual dimorphisms recently uncovered in Australian *Chlamydopsis* (Caterino, 2003), it might immediately be suggested that many of the species described here represent different sexes of the same species. In addition, some of the morphological diversity described here does correspond to sexual differences known in *Chlamydopsis*, mainly the distinct elytral textures; in many species of *Chlamydopsis*, the males' elytra are strongly textured while the females' are smooth. However, in the present situation, sexual dimorphism is unlikely for several reasons, and at least cannot apply to most of the taxa here. First, in *C. angulata* the single male and female specimens are essentially identical in external morphology. Second, it's clear that males are more commonly collected than females. Males are known for 13 species, while females are known for 6. The distinctive forms which might be expected consistently to represent one sex, those with impunctate elytra, represent both sexes (though three of these four are female). A more likely explanation of the biased samples may lie in differing dispersal tendencies of the sexes. Of the species known from females, 3 of the 6 were taken by substrate sampling (either by litter sifting or by pyrethrum fogging). These were not flying. All male specimens, on the other hand, were taken in flight intercception traps.

Though lacking specific information on hosts, a significant possible threat to these probable myrmecophiles should be mentioned. An introduced ant, *Wasmannia auropunctata* (Roger) (also known as the 'little fire ant', 'tramp ant', or 'fourmi electique') is now widespread in New Caledonia. This aggressive species has been documented to displace native ant species in many areas (Clark et al., 1982; Armbrecht & Ulloa-Chacón, 2003), and is having similar effects in New Caledonia (Le Breton et al., 2003). This

TABLE 1. Characters

1. Frons, outline. *1.* lateral margins rounded, without lateral marginal stria, outline distinctly interrupted at antennal insertions (Figs 7B, 8A); *2.* margins straight, usually parallel (sometimes slightly convergent) and with marginal stria, outline not markedly interrupted by antennal insertions.
2. Frons, surface. *1.* more or less flat, without prominent tubercles; *2.* with one or more pairs frontal tubercles (Fig. 8A).
3. Mentum. *1.* a flat, external sclerite, basally articulated and separate from prementum (ligula); *2.* not present as a separate sclerite, either fused with submentum or with prementum (Figs 6, 8C). This character is only informative with respect to outgroups (i.e., of taxa included here, state '2' is only seen in *P. magna*).
4. Submentum. *1.* delimited posteriorly by sutures which diverge from median gular suture; *2.* indistinguishably fused with head; gular sutures ending freely or absent (Figs 6, 8C). Similar to above, this character varies only among outgroups, with *Chlamydonia* and *Kanakopsis* both exhibiting state '2'.
5. Labial palpus. *1.* with three palpomeres; *2.* with two palpomeres. The plesiomorphic labial palpus clearly comprises 3 palpomeres. This has been reduced to two in Pheidoliphila and related genera. A minute third (basalmost) palpomere is present in *Chlamydonia* and *Kanakopsis*.
6. Maxillary palpus. *1.* with four palpomeres; *2.* with three palpomeres. Prior to discovery of these taxa, this reduction in maxillary palpal segmentation had been found in exactly the same taxa as the reduction in labial palpal segmentation (the preceding character), and it was considered that as serial homologues they might not have been completely independent. However, *Chlamydonia* and *Kanakopsis* show the characters to be evolving independently, showing loss of a maxillary palpomere, but with the basal labial palpomere reduced while still present.
7. Median pronotal projections. *1.* present as simple tubercles at anterior margin; *2.* developed as carinae extending posterad from margin; *3.* present, but otherwise developed (frequently as elaborate processes, in several outgroups); *4.* absent.
8. Lateral pronotal marginal alae. *1.* elevated more strongly than median projections; *2.* elevated less strongly than median projections; *3.* lateral alae absent. These 'alae' represent the lateral, arcuate portions of the anterior pronotal margin, forming the upper margin of the antennal cavities, which are elevated to varying degrees.
9. Posterolateral pronotal tubercles. *1.* absent; *2.* present. In addition to anterior marginal pronotal tubercles, some species exhibit small, discrete tubercles in the posterolateral quadrant of the pronotum.
10. Anterior marginal prosternal stria. *1.* complete; *2.* obsolete, at least at middle.
11. Prosternal/mesosternal junction: *1.* mesosternum projecting, prosternum emarginate; *2.* prosternum posteriorly truncate to rounded, projecting over anterior margin of mesosternum.
12. Scutellum. *1.* easily visible (Fig. 2A); *2.* completely hidden beneath junction of anteromedial elytral corners; *3.* visible within triangular opening between elytral bases, but receded, on a lower plane than elytra (Fig. 2B).
13. Elytron, marginal stria: *1.* continuous around all edges, including along elytral suture; *2.* absent at least for short distance along suture.
14. Accessory epipleural stria. *1.* absent; *2.* present (Fig. 8B).
15. Epipleural pits. *1.* absent; *2.* one or two discrete pits present above apex of accessory epipleural stria.
16. Epipleural surface of trichome disc. *1.* convexity not delimited posteriorly by vertical depression; *2.* convexity of outer surface of trichome delimited posteriorly by vertical depression.

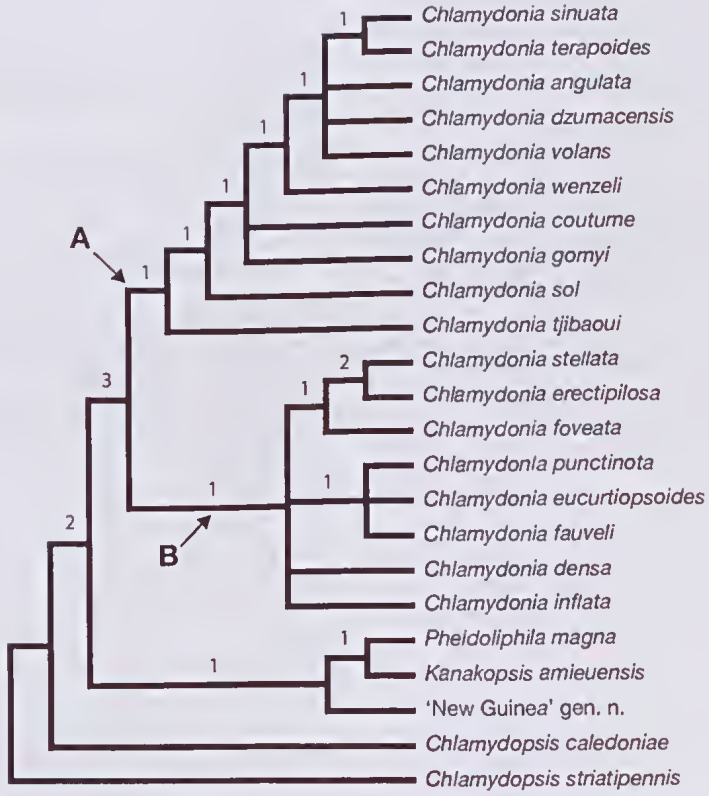
[Note: Trichome morphology is very distinctive in *Chlamydonia*, and homologizing states to outgroups is extremely speculative. Outgroups are thus coded as missing for most of these characters (17-28).]

17. Anterior superficial groove of trichome. *1.* with anterior groove up middle of anterior elevation; *2.* with anterior groove oblique, entering trichome from scutellar corner. This character is only informative with respect to outgroups, as the anterior superficial groove is not observed in any *Chlamydonia*.
18. Anterior basal trichome incision. *1.* narrow, open to epipleuron (Fig. 11); *2.* broadening at bottom, undercutting base of trichome, open to epipleuron (Fig. 17); *3.* closed laterally, ending on dorsum (Fig. 25).
19. Posterior basal trichome incision. *1.* narrow, open to epipleuron (Fig. 11); *2.* broadening at bottom, undercutting base of trichome, open to epipleuron (Fig. 17); *3.* closed laterally, ending on dorsum (Fig. 25).
20. Posterior basal trichome incision. *1.* with setal fringe continuous from disc around edge of incision to its posterior edge (Fig. 22); *2.* with setal fringe interrupted at (lateral) apex of incision (Fig. 26A). *3.* Setal fringe confined to transverse humeral 'notch'. State three applies only to *Kanakopsis*.
21. Trichome disc, surface curvature. *1.* forming a continuous curve from epipleuron to dorsal part; *2.* curvature interrupted from epipleuron to dorsal portion of disc, usually by a distinct carina. *3.* Trichome not in the form of a disc. State three applies only to *Kanakopsis*.
22. Trichome fringe, extent. *1.* present along entire inner edge of anterior disc (Fig. 10); *2.* present only along posterior portion of anterior disc (Fig. 26). *3.* Trichome not in the form of a disc. State three applies only to *Kanakopsis*.
23. Trichome fringe, projection. *1.* horizontal, directed either mesad, or toward center of trichome; *2.* vertical, erect.
24. Trichome fringe, origins. *1.* single series along edge of trichome disc; *2.* with additional 'bundles' of setae arising from surface of trichome disc parallel to marginal fringe (Fig. 16B).
25. Trichome fringe, length. *1.* short to moderate in length; *2.* long, projecting conspicuously above elytral surface.
26. Trichome, median fovea. *1.* absent (Fig. 28A); *2.* small, a simple pore (Fig. 28B); *3.* larger, confluent with dorsal opening (Fig. 28C).
27. Trichome, posterolateral carina. *1.* absent; *2.* present, ending freely (Fig. 11A); *3.* present, extending to elytral margin (Fig. 21).
28. Trichome, posterior base. *1.* at level of elytral surface (Fig. 11B); *2.* elevated, such that posteromedian carina rises to inner posterior corner of fringe (Fig. 18).
29. Elytral disc, surface texture. *1.* smooth, impunctate; *2.* densely punctate.
30. Posterior tibia, outer margin. *1.* angulate; *2.* arcuate.
31. Posterior tibia, width. 1. widest about one-third from base; *2.* widest beyond midpoint.

FIG. 29. Strict consensus of 24 equally parsimonious trees. Numbers on branches indicate decay support. Letters indicate clades discussed in text.

TABLE 2. Character state data for *Chlamydonia* and outgroups.

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Chlamydopsis striatipennis	1	1	1	1	1	1	4	1	1	1	1	1	2	1	1	?	1	?	?	?	?	?	?	?	?	?	?	?	2	1	?
Chlamydopsis caledoniae	1	1	1	2	1	1	4	1	1	1	1	1	2	1	1	?	1	?	?	?	?	?	?	?	?	?	?	?	2	2	?
New Genus 'New Guinea'	1	1	1	2	?	?	4	1	1	1	1	2	1	1	1	?	1	?	?	?	?	?	?	?	?	?	?	?	1	2	?
Pheidoliphila magna	2	1	2	2	2	2	3	3	1	1	2	2	1	1	1	?	1	?	?	?	?	?	?	?	?	?	?	?	1	2	?
Kanakopsis amieuensis	1	1	1	2	1	?	4	3	1	1	1	?	1	1	1	?	2	?	?	3	3	3	1	1	1	1	1	2	1	2	1
Chlamydonia sol	1	2	1	2	1	2	1/2	1	1	1	1	3	1	2	1	1	2	1	1	1	1	1	1	1	1	3	2	2	2	2	1
Chlamydonia coutume	1	2	1	2	1	2	1	1	1	1	1	3	1	2	1	1	2	1	1	1	1	1	1	1	1	3	1	1	2	1	1
Chlamydonia gomyi	1	2	1	2	1	2	2	1	2	1	1	3	1	2	1	1	2	1	1	1	2	1	1	1	1	2	2	1	2	1	1
Chlamydonia tjibaoui	1	2	1	2	1	2	2	2	1	1	1	3	1	2	1	1	2	2	2	1	1	1	1	1	1	3	3	2	2	2	1
Chlamydonia foveata	1	2	1	2	1	2	2	1	1	2	1	3	1	2	1	1	2	2	2	1	1	1	2	1	1	2	2	2	2	1	1
Chlamydonia densa	1	2	1	2	1	2	1	1	1	2	1	3	1	2	1	2	2	2	2	1	1	1	1	1	1	1	1	1	2	1	1
Chlamydonia inflata	1	2	1	2	1	2	2	1	2	2	1	3	1	2	1	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	1
Chlamydonia stellata	1	2	1	2	1	2	1	1	2	2	1	3	1	2	1	1	2	2	2	1	1	1	2	2	2	2	1	1	2	1	1
Chlamydonia erectipilosa	1	2	1	2	1	2	1	1	1	2	1	3	1	2	1	1	2	2	2	1	1	1	2	2	2	2	3	2	1	2	1
Chlamydonia punctinota	1	2	1	2	1	2	1	1	2	2	1	3	1	2	1	2	2	2	2	1	1	1	1	1	1	1	3	2	1	2	1
Chlamydonia eucurtiopsoides	1	2	1	2	1	2	2	1	2	2	1	3	1	2	1	2	2	2	2	1	1	1	1	1	1	1	3	2	1	2	1
Chlamydonia fauveli	1	2	1	2	1	2	1	1	1	2	1	3	1	2	1	2	2	2	2	1	1	1	1	1	1	1	3	2	1	2	1
Chlamydonia angulata	1	2	1	2	1	2	2	1	1	2	1	3	1	2	2	1	2	3	3	2	2	2	1	1	1	3	1	2	2	1	1
Chlamydonia wenzeli	1	2	1	2	1	2	4	1	1	1	1	3	1	2	1	1	2	3	3	1	2	2	2	1	2	3	1	2	2	1	1
Chlamydonia sinuata	1	2	1	2	1	2	1	1	1	1/2	1	3	1	2	1	1	2	3	3	1	2	2	1	1	1	3	1	2	2	2	2
Chlamydonia terapoides	1	2	1	2	1	2	2	1	1	2	1	3	1	2	2	1	2	3	3	1	2	1	1	1	1	3	1	1	2	2	2
Chlamydonia dzumacensis	1	2	1	2	1	2	2	1	1	2	1	3	1	2	1	1	2	3	3	1/2	2	2	1	1	1	3	1	2	2	1	1
Chlamydonia volans	1	2	1	2	1	2	1	1	1	2	1	3	1	2	1	1	2	3	3	2	2	2	1	1	1	3	1	2	2	1	1



highlights a rather urgent need to obtain host data for these beetles in order to effectively assess their potential endangerment.

This paper nearly doubled the known size of the New Caledonian histerid fauna. That these represent the first records of Chlamydopsinae for the island group further illustrates how inadequate our knowledge of terrestrial biodiversity really is, even in areas with a relatively long history of study. Thus the need for additional exploration and intensive taxonomic study is greater than ever, if we hope to document a sizeable fraction of this diversity before it disappears.

ACKNOWLEDGEMENTS

First and foremost I would like to thank Geoff Monteith, for his remarkable dedication to entomological exploration. This study would have been impossible without his contributions. I also thank Tomas Laekner, Slawomir Mazur, and Alexey Tishechkin for providing important specimens, Nicolas Dégallier for his helpful advice on this and related studies, and two anonymous reviewers for helpful suggestions on improving the manuscript. The SEM used in this study was acquired through a National Science Foundation grant (NSF-MRI 0420726), and I thank Daniel Geiger for assistance in its operation. This work was supported in part by the Schlinger Foundation.

LITERATURE CITED

ARMBRECHT, I. & ULLOA-CHACÓN, P. 2003. The little fire ant Wassmania auropunctata (Roger) (Hymenoptera: Formicidae) as a diversity indicator of ants in tropical dry forest fragments of Columbia. Environmental Entomology 32: 542-547.

BREMER, K. 1994. Branch support and tree stability. Cladistics 10: 295-304.

CATERINO, M.S. 2003. New species of Chlamydopsis (Histeridae: Chlamydopsinae), with a review and phylogenetic analysis of all known species. Memoirs of the Queensland Museum 49 (1): 159-235.

CLARK, D.B., GUAYASAMIN, C., MAZAMIO, O., DONOSO, C. & PAEZ DE VILLACIS, Y. 1982. The tramp ant *Wasmannia auropunctata*: autoecology and effects on ant diversity and distribution on Santa Cruz Island, Galapagos. Biotropica 14: 196-207.

DÉGALLIER, N. & CATERINO, M.S. 2005. Notes taxonomiques sur les Chlamydopsinae et descriptions d'espèces nouvelles. – I. Genres *Ceratohister* Reichensperger, *Eucurtiopsis* Silvestri et *Orectoscelis* Lewis. Bulletin de la Société Entomologique de France 110(3): 299-326.

FAUVEL, A. 1891. Les Coléoptères de la Nouvelle-Calédonie et dépendances avec descriptions, notes, et synonymies nouvelles. Revue d'Entomologie 10: 148-182.

GOMY, Y. 1976. Contribution à la connaissance des Histeridae de Nouvelle-Calédonie. Nouvelle Revue d'Entomologie 6: 153-171.

GOMY, Y. 1982. Contribution à la connaissance des Histeridae de Nouvelle-Calédonie (Deuxième note). Nouvelle Revue d'Entomologie. 12: 151-159.

LE BRETON, J., CHAZEAU, J. & JOURDAN, H. 2003. Immediate impacts of invasion by *Wasmannia auropunctata* (Hymenoptera: Formicidae) on native litter ant fauna in a New Caledonian rainforest. Austral Ecology 28: 204-209.

MADDISON, D.R. & MADDISON, W.P. 2003. MacClade 4, version 4.06. Sinauer Associates: Sunderland.

SORENSON, M.D. 1999. TreeRot, version 2. Boston University: Boston.

SWOFFORD, D.L. 2003. PAUP*: Phylogenetic Analysis Using Parsimony, version 4.0b10. Sinauer Associates: Sunderland.

TAYLOR, R.W. 1987. A checklist of the ants of Australia, New Caledonia and New Zealand. CSIRO Australia Division of Entomology Report No. 41: 1-92.

WENZEL, R.L. 1955. The histerid beetles of New Caledonia. Fieldiana, Zoology 37: 601-634 + plates.

LITORIA RICHARDSI SP. NOV., A NEW TREEFROG (ANURA: HYLIDAE) FROM NEW GUINEA

ANDREW J. DENNIS AND MICHAEL J. CUNNINGHAM

Dennis, A.J. & Cunningham, M.J. 2006 11 10: *Litoria richardsi* sp. nov., a new treefrog (Anura: Hylidae) from New Guinea. *Memoirs of the Queensland Museum* **52** (1): 65-70. Brisbane. ISSN 0079-8835.

A distinctive new species of *Litoria* is described from central New Guinea. It is a small species (adult female 29.5mm; adult male 26.5mm SVL) with full, thick, black webbing on the hands and feet. In life the ventral surface is strikingly patterned with black, white and yellow. The periphery of the tympanic membrane is transparent, a character shared with only one other Australopapuan hylid frog. The relationship of this species to other *Litoria* is unclear. It does not appear to belong in any of the currently recognised species-groups within the genus. ❐ *Hylidae, Litoria, new species, New Guinea, rainforest.*

Andrew J. Dennis, CSIRO Sustainable Ecosystems and the Rainforest CRC, PO Box 780, Atherton, Qld 4883, Australia. (email: Andrew.Dennis@csiro.au); Michael J. Cunningham, University of the Free State, Qwaqwa, Private Bag X13, Phuthaditjhaba 9866, South Africa; 9 September 2005.

The Australopapuan hylid frog genus *Litoria* occurs in habitats ranging from deserts to wet rainforests. The genus is particularly diverse in New Guinea where recent field work has revealed numerous undescribed taxa (Richards, 2001; Richards & Iskandar, 2001, Richards et al., 2000). During 1995 we collected a single specimen of a striking new species of *Litoria* in the foothills of the Star Mountains, Papua New Guinea. Intensive searches at this locality between 1991 and 1999 failed to detect additional specimens but another was collected in the Mamberamo River Basin of Papua Province, Indonesia in 2000 (Richards et al., 2002).

MATERIALS AND METHODS

Specimens are deposited in the South Australian Museum (SAMA), Australia and the Museum Zoologie Bogor (MZB), Indonesia. Measurements (to the nearest 0.1mm) were taken with dial callipers and a stereomicroscope fitted with an ocular micrometer, and follow Menzies (1993). They are: SVL (snout-vent length), TL (tibia length), HW (head width at tympanum), HL (head length from tip of snout to posterior edge of tympanum), EYE (horizontal eye diameter), TYM (horizontal tympanum diameter), IN (internarial distance), EN (distance between anterior edge of eye and posterior edge of naris), 3FD (width of 3rd finger disc at right angle to digital axis) and 3FP (width of penultimate phalanx of 3rd finger), 4TD and 4TP (4th toe disc and 4th toe phalanx, as for 3rd finger).

SYSTEMATICS

Litoria richardsi sp. nov.
(Figs 1-2)

MATERIAL. HOLOTYPE: SAMA R60283, adult ♀, 5.5km west of Tabubil township, Western Province, Papua New Guinea (5°17'30"S, 141°11'55"E; Alt. 500m asl), collected by A. Dennis, S. Richards, M. Cunningham 18.XI.1994. PARATYPE: MZB Amph. 11823, adult ♂, forest adjacent to Tiri River, Mamberamo Drainage, Papua, Indonesia (3°17'30"S, 138°34'53"E; Alt. 80m asl) collected by S. Richards and B. Tjaturadi 12.IX.2000.

DIAGNOSIS. Assigned to *Litoria* on the basis of a horizontal pupil when constricted. Small (♂ 26.5mm, ♀ 29.5mm); full, thick, black webbing on fingers and toes; colour in life predominantly grey-green dorsally merging to blue-grey laterally and on posterior dorsum, marked with irregular black lines and numerous tubercles; venter with extensive areas of black, white and yellow; periphery of tympanic membrane transparent.

DESCRIPTION. *Female.* (Figs 1A, C-D) Holotype measurements (mm). SVL 29.5; TL 17.5; HW 8.6; HL 8.4; EYE 3.2; TYM 2.2; IN 2.6; EN 3.1; 3FD 1.5; 3FP 1.0; 4TD 1.2; 4TP 0.9. Head slightly broader than long (HL/HW 0.98), less than one third of snout-vent length (HL/SVL 0.28); snout slightly rounded in dorsal aspect, blunt; near vertical in lateral view. Canthus rostralis rounded, gently curved; loreal region distinctly concave. Nostrils close to tip of snout; internarial distance less than distance between naris and eye (EN/IN 1.19). Eyes large (EYE/SVL 0.11), pupil

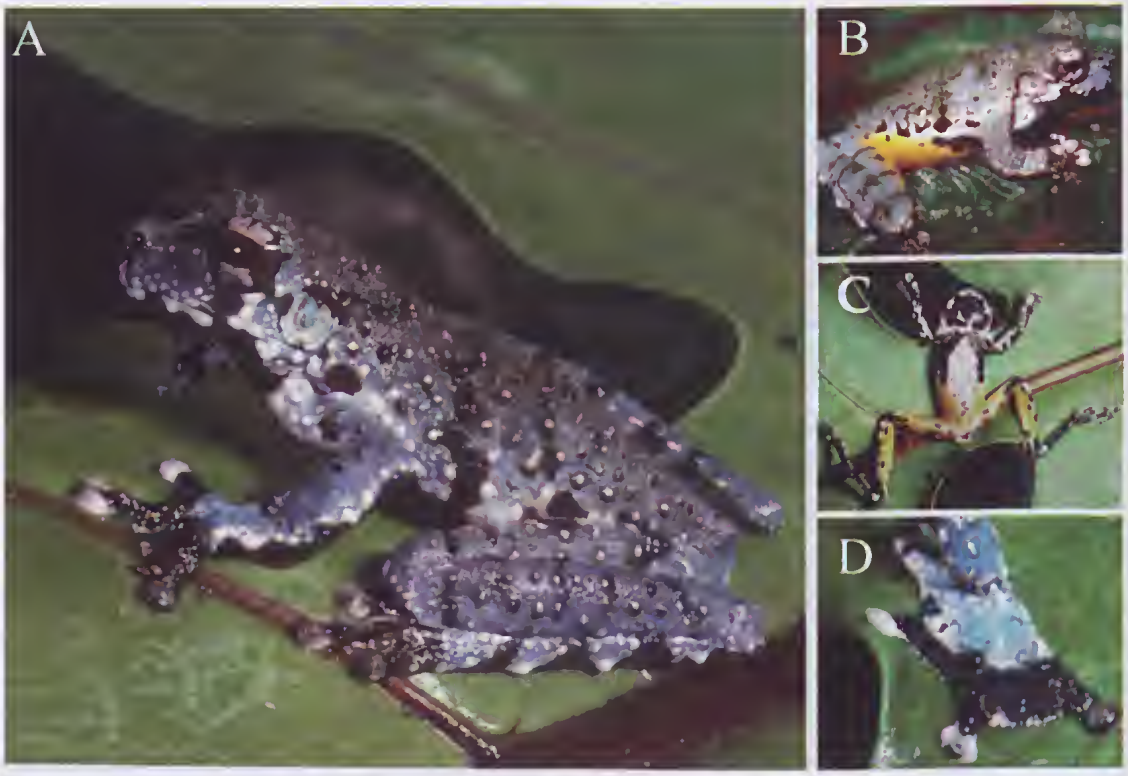


FIG. 1. *Litoria richardsi* sp. nov. A, adult female holotype habitus; B, adult male paratype habitus; C, female holotype ventral; D, female holotype hand.

horizontal. Vomerine teeth poorly developed, in two small clumps between choanae; tongue cordiform. Tympanum clearly visible; periphery of tympanic membrane transparent; dorsal, anterior and ventral edges with increasingly smaller black patches, centre aqua. Fingers long, extensively webbed, relative lengths 3>4>2>1; webbing black, fleshy, reaching penultimate tubercle on 3rd and 4th fingers and extending to discs as a broad fleshy fringe; webbing reaching disc on 2nd finger. Terminal discs are large (3FP/3FD 0.67). Black webbing reaching to discs on toes 5, 3 and 2, to penultimate tubercle on toe 4, and slightly short of disk on toe 1; relative lengths 4>5=3>2>1, terminal discs moderate (4TP/4TD 0.75).

Colour pattern. In life, predominantly blue-grey (Fig. 1A), merging into grey-green on upper dorsum with irregular black bars across body; foot with triangular black cross bars and prominent white tubercles laterally (Fig. 1A). Numerous conical tubercles on limbs and dorsum including snout; tubercles white on lateral part of body; white, grey-green, blue-grey or black on dorsum and limbs; four prominent blue-grey tubercles along top of eyelids; series of white spots and tubercles running from rear edge of eye to angle of jaws and extending backwards to point of arm insertion. Iris with black anterior and posterior patches, white dorsally and ventrally with tiny, triangular black incursions from edges. Black stripe through vent is partly interrupted by distinct patch of white tubercles on either side of and below vent. Underside of feet black with scattered white tubercles; legs groin and sides of belly yellow with scattered black patches; belly white, framed by yellow posteriorly and black patches extending from flank to centre of upper chest. Undersides of arms, throat and chin black with extensive white patches, particularly in a band across throat and along lower jaw (Fig. 1C).

Male. (Fig. 1B) Paratype measurements (mm). SVL 26.5; TL 14.4; HW 9.0; HL 7.7; EYE 3.4; TYM 2.3; IN 2.5; EN 2.6; 3FD 1.4; 3FP 1.0; 4TD 1.4; 4TP 0.9. Similar to female in most respects but differing as follows: overall colour more green than blue (Fig. 1B); webbing reaching disc on 2nd finger of right hand and halfway between penultimate tubercle and disc on left hand;

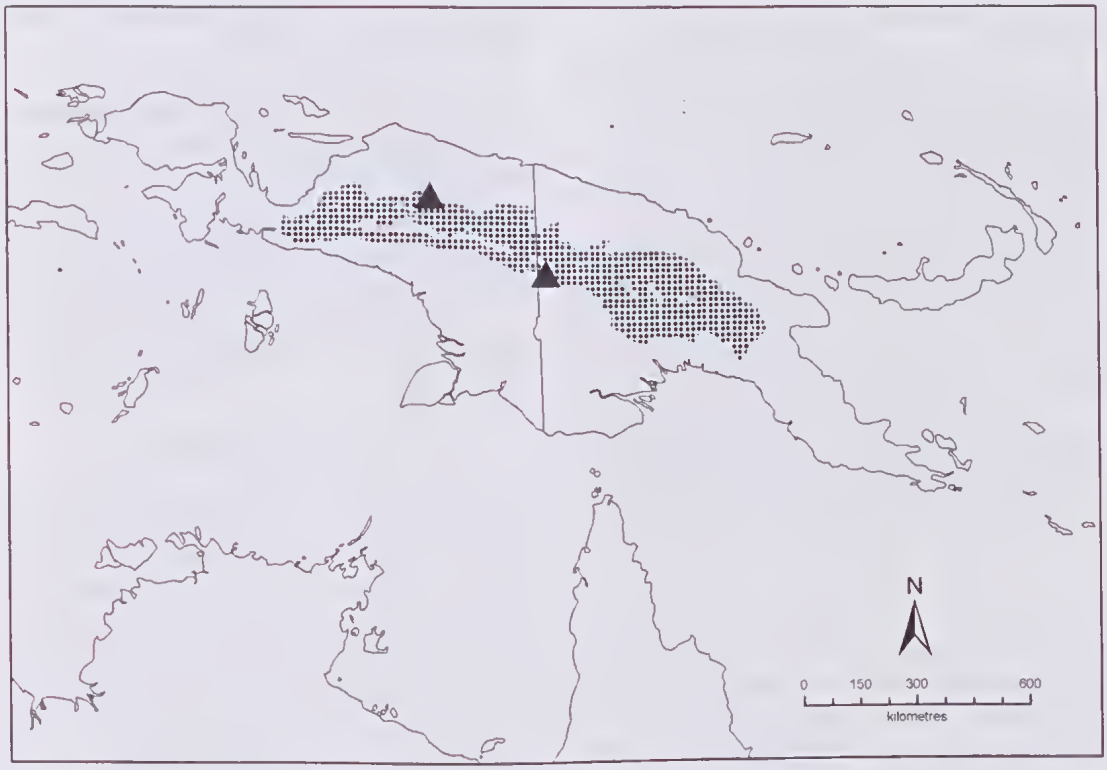


FIG. 2. Map of New Guinea showing collection localities (▲) of *Litoria richardsi*; holotype lower right and paratype upper left. The stippling shows the distribution of Central Range montane rainforest (Olson & Dinerstein, 2002).

relative lengths of toes 4>3>5>2>1. The male has nuptial pads and vocal slits and was captured calling from a leaf ~ 3m high during heavy rain in rainforest at night. The nuptial pads were low, brown and rugose; fitting the structural class of generalised nuptial excrescence (Duellman, 2001).

NATURAL HISTORY. The gravid female holotype was caught at approximately 2200 hours on a low shrub (~1.5m) on the edge of Ok Ma swamp west of Tabubil. Her eggs were at a range of stages, from tiny and unpigmented to mature and heavily pigmented, measuring 1.1mm in diameter. One batch of seven eggs was mature. A second batch of ten less mature eggs all appeared to be at the same stage of development, suggesting that breeding may be sporadic in small clutches. A minimum of fifty eggs could be counted without damaging the specimen but other tiny eggs were visible beneath these, suggesting between 50 and 100 eggs in total. Despite intense searches, no males of the species were found calling in her vicinity. This may have been due to some parts of the swamp being inaccessible to collectors due to sago palm thickets and deep water. The habitat was complex rainforest in a very wet area (~12000mm of rain per year). The calling male was caught at night, during heavy rain, from a leaf ~3m above a forest trail. It too was in complex, very wet rainforest but at a lower altitude. No other individuals were found calling nearby; nor was there a swamp in the vicinity.

CALL. The call was a harsh chirp, reminiscent of a cricket.

ETYMOLOGY. For Stephen Richards in recognition of his immense contribution to understanding the herpetofauna, its diversity and its conservation, on the island of New Guinea.

DISTRIBUTION. Known only from two localities (Fig. 2): one at mid altitude (500m) in the mountainous headwaters of the Fly River in Western Province, New Guinea; the other at low altitude (80m) to the west in the Tiri River, Mamberamo Drainage, Papua, Indonesia. The species is likely to occupy most of the intervening suitable habitat.

COMPARISON. The new species differs from all Australopapuan hylid frogs in having thick

black webbing between the fingers and toes and from all species, except the recently described *Litoria singadanae* Richards, in having a partially transparent tympanum (Richards, 2005). Fully webbed fingers distinguish *L. richardsi* from members of the *L. bicolor* group; *L. albolabris* (Wandolleck), *L. majikthise* Johnston & Richards, *L. rubrops* Kraus & Allison and *L. leucova* Tyler, all of which have only basal webbing on the fingers (Tyler, 1968; Tyler & Davies, 1978; Kraus & Allison, 2004) as well as a range of other differentiating characters. *Litoria richardsi* differs from *L. havina* Menzies and *L. mucro* Menzies by lacking a rostral spike; from *L. ollauro* Menzies and *L. umarensis* Günther in having a yellow rather than blue or brown-black inner thigh colour; from *L. wapogaensis* Richards & Iskandar in having a mottled blue-grey to grey-green dorsum rather than a green dorsum with yellow spots; from *L. verae* Günther in being smaller (SVL 26.5 - 29.5mm vs 33.5 – 40.8mm) and having a large and partially transparent tympanum (TYM/EYE 0.68-0.69) rather than a small (TYM/EYE 0.44-0.51) and opaque one; from *L. singadanae* in its striking black ventral markings; and from members of the *L. aruensis* group by lacking a pale stripe along the canthus rostralis and uniform green dorsum (Menzies, 1993; Johnston & Richards, 1994; Richards & Iskandar, 2001; Günther 2004; Menzies & Tyler, 2004; Richards, 2005).

DISCUSSION

Litoria richardsi is a very distinctive species. The full, black webbing, the venter with extensive areas of black, white and yellow and a transparent periphery on the tympanic membrane combined with a small size (<30mm) distinguish *L. richardsi* from all congeners. It does not fit clearly into any of the species groups identified by Tyler & Davies (1978). At a broad level, *L. richardsi* fits Category B of Tyler & Davies (1978); being arboreal, having extensive webbing on the fingers and pigmented eggs. Species groups in this category with extensive webbing on the fingers are either large (e.g. *L. eucnemis* group, *L. peroni* group), uniformly green (e.g. *L. aruensis* group) or have a rostral spike (e.g. *L. prora* group) (Tyler & Davies, 1978). *Litoria richardsi* has several characters similar to those of the *Litoria becki* group, including dark pigments on the ventral surface, coarsely granular skin, small size and fully webbed toes. However, *Litoria richardsi* has extensive webbing on the fingers and pigmented eggs, whereas members of the *L. becki* group usually have unwebbed fingers and unpigmented eggs (Tyler & Davies, 1978).

Given the extensively webbed fingers and toes and the extreme difficulty in locating specimens, *L. richardsi* is likely to be a canopy dweller and may glide. The small number of mature eggs compared to the number of eggs developing at different stages suggests that it lays small clutches regularly. Its high rainfall habitat and small clutch size suggest that the species may lay in small canopy ponds (those trapped in tree forks and hollows and regularly replenished by high rainfall) as well as in swamps or ponds on the forest floor.

ACKNOWLEDGEMENTS

Ok Tedi Mining Limited provided valuable logistical support during our fieldwork. We are particularly grateful to Ian Wood, Andrew Storey and Ian Roderick of the Environment Department, The Gregory family and James Menzies provided valuable assistance. Roselyn Busasa (Institute of Papua New Guinea Studies) and Dr Navu Kwapena (Department of Conservation and Environment) facilitated processing of our research and export visas. Thanks to Caroline Bruce for producing the map. We thank S.J. Richards and B. Tjaturadi for finding and providing the paratype and Conservation International for funding their survey.

LITERATURE CITED

DUELLMAN, W.E. 2001. Hylid frogs of Middle America (Revised Edition). (Society for the Study of Amphibians and Reptiles: St Louis).

GÜNTHER, R. 2004. Two new treefrog species of the genus *Litoria* (Anura: Hylidae) from the west of New Guinea. Zoologische Abhandlungen (Dresden) 54: 163-175.

JOHNSTON, G.R. & RICHARDS, S.J. 1994. A new species of *Litoria* (Anura: Hylidae) from New Guinea and redefinition of *Litoria leucova* (Tyler, 1968). Memoirs of the Queensland Museum 37: 273-280.

KRAUS, F. & ALLISON, A. 2004. A new species of *Litoria* (Anura: Hylidae) from southeastern New Guinea. Herpetologica 60: 97-103.

MENZIES, J.I. 1993. Systematics of *Litoria iris* (Anura: Hylidae) and its allies in New Guinea and a note on sexual dimorphism in the group. Australian Journal of Zoology 41: 225-255.

MENZIES, J.I. & TYLER, M.J. 2004. *Litoria gracilenta* (Anura: Hylidae) and related species in New Guinea. Australian Journal of Zoology 52: 191-214.

OLSON, D.M. & DINERSTEIN, E. 2002. The global 200: Priority ecoregions for global conservation. (PDF file) Annals of the Missouri Botanical Garden 89: 125-126.

RICHARDS, S.J. 2005. A new species of treefrog (Anura: Hylidae: *Litoria*) from the Huon Peninsula, Papua New Guinea. Zootaxa 1052: 29-39.

RICHARDS, S.J. & ISKANDAR, D.T. 2000. A new minute *Oreophryne* (Anura: Microhylidae) from the mountains of Irian Jaya, Indonesia. Raffles Bulletin of Zoology 48: 257-262.

2001. A new tree frog (Anura, Hylidae, *Litoria*) from the mountains of Irian Jaya, Indonesia. Alytes 18: 141-152.

RICHARDS, S.J., ISKANDAR, D.T. & ALLISON, A. 2000. Amphibians and reptiles of the Wapoga River Area, Irian Jaya, Indonesia. Pp. 54-57 In Mack, A. & Alonso, L. (eds) A biological assessment of the Wapoga River area of northwestern Irian Jaya, Indonesia. RAP Bulletin of Biological Assessment 14. (Conservation International: Washington DC).

RICHARDS, S.J., ISKANDAR, D.T. & TJATURADI, B. 2002. Amphibians and reptiles of the Dabra area, Mamberamo River Basin, Papua, Indonesia. Pp. 76-29 In Richards, S.J. & Suryadi, S. (eds) A Biological Assessment of Yongsu - Cyclops Mountains and the Southern Mamberamo Basin, Papua, Indonesia. RAP Bulletin of Biological Assessment 25. (Conservation International: Washington DC).

TYLER, M.J. 1968. Papuan hylid frogs of the genus *Hyla*. Zoologische Verhandelingen (Leiden) 96: 3-203.

TYLER, M.J. & DAVIES, M. 1978. Species-groups within the Australopapuan Hylid frog genus *Litoria* Tschudi. Australian Journal of Zoology, Supplementary Series 63, 1-47.

SEA TURTLES NESTING IN THE SIR EDWARD PELLEW ISLANDS, GULF OF CARPENTARIA, NORTHERN TERRITORY

MARK HAMANN, CHLOE SCHÄUBLE, TOM SIMON, JOHNNY JOHNSON, SAMMY EVANS, TONY DORR AND ROD KENNETT

Hamann, M., Schäuble, C.S., Simon, T., Johnson, J., Evans, S., Dorr, T. & Kennett, R. 2006 11 10: Sea turtles nesting in the Sir Edward Pellew Islands, Gulf of Carpentaria, Northern Territory. *Memoirs of the Queensland Museum* **52**(1): 71–78. ISSN 0079-8835.

The northern coastline of Australia supports globally significant populations for at least four species of sea turtles. While Queensland and to a lesser degree Western Australian populations have received considerable attention over the last three decades, there have been few detailed studies of sea turtle rookeries in the Northern Territory. Much of the NT coastline is under the ownership of Aboriginal people, and thus their involvement in any management or conservation of sea turtles is essential. In this study we combined local Aboriginal knowledge with orthodox quantitative sea turtle survey methods to collect baseline information on sea turtle populations in the Sir Edward Pellew Islands (Gulf of Carpentaria). Although four species of sea turtles use these islands for nesting, Flatback (*Natator depressus*) and Green Turtles (*Chelonia mydas*) are the most abundant. Nesting appears to be scattered throughout the islands with the largest concentrations of *C. mydas* and *N. depressus* utilising the beach on north-eastern Vanderlin and northern West Island respectively. Hatchling production was high for both species, however the presence of wild dogs and feral cats on West Island may become a management issue for this rookery in future years. ❐ *Sea turtles, Green Turtle, Flatback Turtle, Northern Territory, Sir Edward Pellew Islands, Aboriginal knowledge, management, nesting.*

Hamann, M. (Corresponding author) & Schäuble, C. Key Centre for Tropical Wildlife Management, Charles Darwin University, Darwin, NT 0909 & School of Tropical Environment Studies & Geography, James Cook University, Townsville, Qld 4811 (email: mark.hamann@jcu.edu.au); Simon, T., Johnson, J. & Evans, S. Mabunji Aboriginal Resource Centre, Borroloola, NT 0854; Dorr, T. Key Centre for Tropical Wildlife Management, Charles Darwin University, Darwin, NT 0909; Kennett, R. Key Centre for Tropical Wildlife Management, Northern Territory University, Darwin, NT 0909, Australia & NAILSMA, Tropical Savannas CRC, Faculty of E, H & S, Building 42, Darwin NT 0909; 11 July 2006.

A large area of the Northern Territory (NT) coastline is owned by Aboriginal people. Sea turtle nesting habitat occurs along much of this coastline, and the NT provides habitat for nationally and internationally significant nesting populations of Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*) and Flatback Turtles (*Natator depressus*) (Guinea, 1994a; Chatto, 1997; Environment Australia, 1998). While data are available on the broad geographical distribution of each of these species, detailed nesting beach surveys have been conducted at only a few sites (Guinea, 1994b; Vanderlay, 1997; Schäuble, 2002). In particular, there are few data on nesting rookeries/populations in the Gulf of Carpentaria (GoC).

The Sir Edward Pellew Islands (SEP) are located in the south-western side of the Gulf of Carpentaria at the mouth of the McArthur and Wearyan Rivers (Fig. 1). The SEP group consists of eight main islands and numerous smaller rocky outcrops, and has a combined land area of around 2,100 square kilometres. The SEP group is the traditional land of both the Mara and Yanyula Aboriginal people, many of whom still reside in permanent Aboriginal outstations that exist on four of the islands, i.e. Mammathumburru (West Island), Wathungka (South-west Island), Jimmimila (Black Craggy) and Yuguie (Vanderlin Island) (Bradley, 1997a).

For the Aboriginal people that live on and around the SEP group, sea turtles hold significant cultural and economic value, and both hunting of turtles in foraging areas and egg collection are widely practiced (Bradley, 1997a, b; Baker, 1999). Not surprisingly, Aboriginal people in the SEP area possess detailed knowledge regarding some aspects of sea turtle biology. For example, such information often includes the nesting distribution, species composition and nesting seasonality of turtles breeding in local regions. However, despite extensive aerial surveys over the SEP region, several records in other herpetological

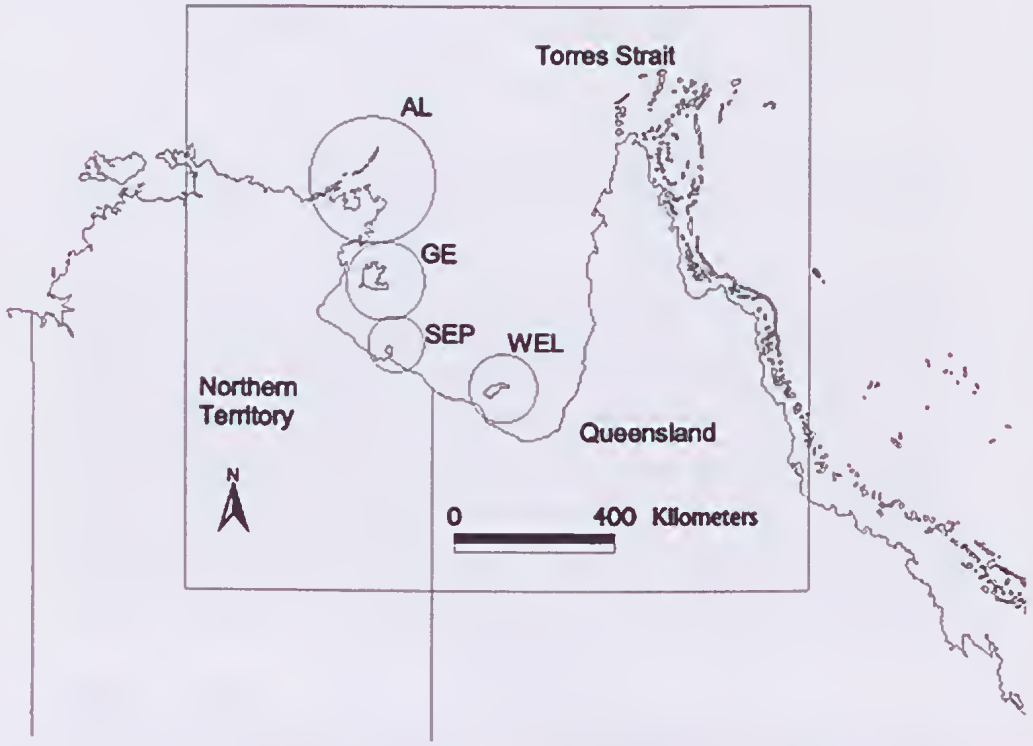


FIG 1. Map of the Gulf of Carpentaria, indicating the location of the Sir Edward Pellew Islands (SEP) in relation to other sea turtle rookeries in this region, AL = north east Arnhem Land, GE = Groote Eylandt, WEL = Wellesley Island group.

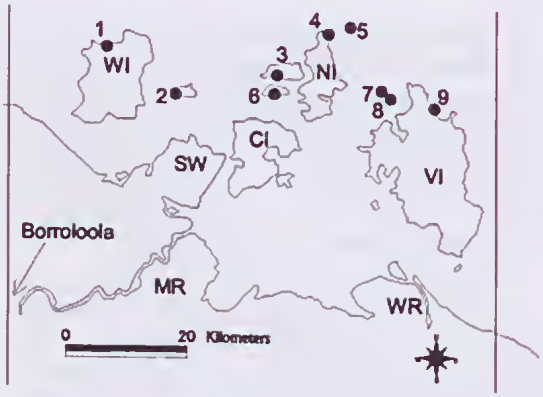


FIG 2. Map of the Sir Edward Pellew Islands showing the locations of turtle nesting sites. WI = West Island, SW = South West Island, CI = Centre Island, NI = North Island, VI = Vanderlin Island, MR = MeArthur River and WR = Wearyan River. •1 = Northern Beach at West Island, •2 = Black Craggy, •3 = Watson Islet, •4 = North Island, •5 = Uquhart Island, •6 = Skull Island, •7 = Turtle Islet, •8 = Small sand bar, •9 = Investigator Bay.

literature (Chatto, 1997; Cogger & Lindner, 1969 and see Limpus & Reed, 1985 for a summary of sea turtle records in the SEP region) and a continuous occupation by Aboriginal people, quantitative data on these and other issues are lacking, e.g. the size of the annual nesting population(s), and hatchling production. Therefore, in the present study we combine the local ecological knowledge provided by three of us (T.S., J.J. & S.E., who are local Traditional Owners/Custodians) with standard turtle survey techniques used by non-Indigenous researchers. We use these sources of information to provide a baseline assessment on sea turtle nesting in the SEP Islands.

METHODS

SURVEY. An aerial survey was flown over the island group on 7 June 2001. Based on data obtained from this flight and discussions with local traditional owners, two beaches were chosen for ground surveys. Information provided to us by traditional owners is identified in the text, either by stating the name of the person or by the

acronym TOI (Traditional Owner Information). We undertook beach surveys of differing durations (from one to seven days), primarily focused on the northern coast of West Island (Fig. 2). Additionally, Investigator Bay on Vanderlin Island and several of the smaller islands (Black Craggy, Turtle Islet and Watson Islet; Fig. 2) were visited occasionally throughout the study period to determine an estimate of turtle nesting density. All survey dates and survey period durations are shown in Table 1.

NESTING TURTLES. Beaches were patrolled on foot each night during survey periods. On arrival at a nesting beach, all tracks from the previous night(s) were recorded and crossed with a foot drag-mark to prevent re-counting on subsequent nights. On the nightly patrols each crawl by a nesting female was recorded and scored according to whether she had laid eggs or not following the methods of Limpus (1985) i.e. a successful nesting attempt was one in which the female oviposited a clutch of eggs, an unsuccessful nesting attempt was one where a female failed to oviposit, and nest sites for which her success at laying eggs could not be determined, were classed as undetermined. For tracks where the turtle was not seen, nesting success was ascertained using characteristics of the track and body pit (Schroeder & Murphy, 1999). Track counts following these methods were conducted on Vanderlin by Archie Johnson on 13 August and 7 September 2001. All turtles encountered were measured (curved carapace length) and tagged with titanium flipper tags (return address QPWS, Brisbane QLD 4002) in the right and left flippers, position three (Limpus, 1985; 1992). Although it was not possible to distinguish between the two species, confirmation to whether either/both Hawksbill (*Eretmochelys imbricata*) and Olive Ridley (*Lepidochelys olivacea*) Turtles nested in the SEP islands was based on descriptions of the size of eggs; numbers of eggs per clutch; track widths and body pit sizes given to us by residents of West Island (R. Dickson, T. Simon & TOI).

CLUTCH SUCCESS. During each patrol of the nesting beach, nests from which hatchlings had emerged were located by following hatchling tracks back up the beach to the nest site. Nests were excavated by digging down to the shell remnants and then sorting the remaining contents into the following categories, empty shell, undeveloped eggs, unhatched eggs, predated eggs, live and dead hatchlings. Unhatched eggs were those with visible signs of embryonic development and undeveloped eggs were those with no visible signs of embryonic development (Limpus, 1985; Miller, 1999). Emergence success of the nest refers to the percentage of eggs that produce hatchlings that made their way to the beach surface. We acknowledge that this method of finding nests is biased as it does not include those nests that fail to produce any hatchlings. Therefore, our data may only be used as an indication of the emergence success of nests that produce some hatchlings to the surface.

RESULTS

NESTING TURTLES. According to local island residents, signs of sea turtle nesting (tracks on the beach) are present all year round. However, the main sea turtle nesting season in this area begins around late May and continues until October (TOI). We only encountered nesting by either *Natator depressus* or *Chelonia mydas*. The average curved carapace length (± standard deviation) was 88.7 ± 2.7cm (range 81.5 to 94.8cm; n = 42) for *N. depressus* and 100.0 ± 1.9cm (range 97.3 to 102.5cm; n = 6) for *C. mydas*. Curved carapace width for *N. depressus* females was recorded in 2002 only, and averaged (± standard deviation) 73.6 ± 2.5 (range 68.0 to 78.0cm; n = 22). We did not re-capture any turtles tagged by us, or by others, although one female (in September 2002) had healed tag scars and it is possible that she was initially tagged while nesting in a previous season (2000 or 2001). Although we did not encounter nesting by *E. imbricata* or *L. olivacea* during any of our field surveys, the traditional owners of West Island indicated to us that turtles smaller than flatback turtles (either *E. imbricata* or *L. olivacea*) arrive early in the nesting season and nest along the far western end of the main nesting beach on West Island (Fig. 2). The number of clutches laid per year by either/both of these species is difficult to estimate, though it is likely to be small: perhaps in the vicinity of <10 per year (Richard Dickson, pers. comm.).

EMERGENCE SUCCESS OF NESTS. During our nightly beach patrols on West Island we found 22 *Natator depressus* emerged nests (containing a mean of 51 ± 7 eggs) and two *Chelonia mydas* clutches (containing 82 and 118 eggs). Note that these clutch counts are based on nest excavations, and not on eggs counted at time of laying, and they may be biased (probably downwards) by error associated with the counting of shells (Cruz & Frazier, 2000). The emergence successes of the *C. mydas* clutches were 95.1% and 98.7%.

The mean emergence sueeess of *N. depressus* clutehes was 91% (± 5%; range 78% to 100%), and the mean percentage of unhatched and undeveloped eggs per clutch were 1.7% (± 0.6%) and 7.9% (± 2.1%) respectively.

MORTALITY RISKS. At West Island we observed very low levels (< 5 instances) of hatchling (*N. depressus*) depredation by crabs. We did not observe any predation of turtle eggs, despite the presence of wild dogs (groups of around five to ten have been sighted) and feral cats (one sighted and many tracks observed along the top of the beach) on the northern beach of West Island. In September 2001, we found one female *N. depressus* that had died on her way back to the water following a nesting attempt. This female showed signs of having been attacked by dogs, though we could not establish whether this attack was pre or post-death. However, during the survey in September 2002, the research team found wild dogs lethally attacking a female while she was ashore nesting. No turtles were found trapped in marine debris or had injuries consistent with shark or crocodile attack. During our studies, local Aboriginal families did not take any clutches of eggs or any nesting females for consumption.

DISCUSSION

The Flatback Turtle, referred to locally as Dhadhiwhanjhni, is listed as a threatened species under the Australian legislation, yet little is known about general biology for the northern and western populations Environment Australia (1998). Moreover, in the species review by Environment Australia, (1998), the nesting population in the general Eastern Arnhem Land area (which includes the Sir Edward Pellew Islands) is recorded as being of undetermined size with a likely involvement of 1000s of females annually. Although some work has been carried out over the last decade in and around the SEP group, previous authors have mainly focused on the broad distribution of nesting sea turtles (Chatto, 1997), the anthropological importance of sea turtles to local Aboriginal people (Bradley, 1997a, b; Baker, 1999), or report occasional observations (Cogger, 1968; Cogger & Lindner, 1969; Limpus & Reed, 1985). Our study, using ground surveys on several of the islands in this group, collected both qualitative and quantitative data and thus present a more detailed and extensive estimation of sea turtle nesting activity in this region of the Gulf of Carpentaria.

DISTRIBUTION AND SIZE OF THE NESTING POPULATIONS. Nesting of both *Natator depressus* and *Chelonia mydas* occur on several of the SEP islands (This study; Cogger, 1968; Chatto, 1997; Bradley, 1997a, b). However, we found the majority of sea turtle nesting activity occurred on two islands, West Island and Vanderlin Island. More specifically at West Island's north beach we recorded nesting by both species at a rate of approximately three *N. depressus* to one *C. mydas* per night. In contrast, on the north-east coast of Vanderlin Island we only recorded nesting by *C. mydas,* and information from local traditional owners and residents indicated that they had not seen *N. depressus* nesting on the island. Furthermore, although most *C. mydas* nesting is concentrated on the north-eastern beaches, during large nesting seasons most of the other sandy beaches on Vanderlin Island also receive small numbers of nesting *C. mydas* (Archie Johnson pers. comm., TOI).

Aside from West and Vanderlin Islands, both Skull and Watson Islands receive small numbers (<100 clutches per year) of nesting turtles (primarily *N. depressus*: this study; Bradley, 1997a, b; Chatto, 1997) and presumably small numbers of *C. mydas* during some breeding seasons. Other possible nesting sites that we did not survey for nesting turtles include the two local mainland beaches (combined length of approximately 40km), North Island, Pearce Island or Urquhart Island. While it is likely that the mainland beaches receive very little nesting (TOI and <10 tracks per kilometre – Chatto, 1997) by either *N. depressus* or *C. mydas*, several authors have suggested that the northern beaches of North Island, Pearce Island and Urquhart Island probably receive an unknown level of sea turtle nesting between July and October each year (Paradice, 1924 [cited in Limpus & Reed, 1985] Cogger, 1968; Cogger & Lindner, 1969; Chatto, 1997). In particular, while *C. mydas* probably nest in small numbers at each location, Pearce Island may receive somewhere in the order of 10s of female *N. depressus* per year. Furthermore, based on both information from TOs (this study; Cogger & Lindner, 1969) and track observation data from Chatto (1997), it also appears that West Island, Urquhart Island and North Island receive some nesting by *E. imbricata* or *L. olivacea*. However, despite 35 days of surveys on West Island we found no additional evidence to confirm or deny that either *E. imbricata* or *L. olivacea*, nests in the region.

Based on the results from our study, combined with the scattered mainland nesting recorded

by Chatto (1997) we estimate that the annual nesting populations of both *N. depressus* and *C. mydas* in the local SEP region is in the low 100s of females. However, estimating the size of green turtle nesting populations based on limited data is difficult, because the size of annual green turtle breeding populations fluctuates widely among years (Limpus & Nicholls, 1988; 2000). Given large annual fluctuations and unpublished Queensland Parks and Wildlife Service (QPWS) data indicating that 2001 was a slightly below average nesting year in Queensland (Limpus et al. 2003 for data on the number of females nesting each year), our single season of data for *C. mydas* may underestimate average nesting densities. There is currently no published data available on long-term fluctuations of *N. depressus* nesting populations, and a relationship between the numbers of females nesting each year and El Niño Southern Oscillation has not been described for this species. Thus we cannot rule out a similar error for our estimates of the *N. depressus* nesting population.

DIRECT TAKE OF FEMALES AND EGGS. The harvest of turtle eggs for consumption by local Aboriginal people is reportedly small (TOI) and consists of opportunistic gathering when weather permits access to the nesting beaches. Indeed, local island residents (Archie Johnson, Steve Johnson, Richard Dickson and Thomas Simon) indicated to us that this harvest would rarely exceed more than five *N. depressus* clutches and 10 *C. mydas* clutches per year across all islands. Similarly, the hunting of nesting turtles from beaches in the SEP area is rare. There are at least three other major influences on the green turtle population in the Gulf of Carpentaria. First, a direct, and unquantified take of nesting turtles from nesting beaches exists in other areas, e.g. Groote Eylandt (Hamann & Wohling unpub. data), the Wellesley Island group (Angus McIvor, Wellesley Islands Aboriginal Corporation, pers. comm.) and north-east Arnhem Land (Kennett et al., 1997). Second, there is a direct take of turtles from their foraging areas both by Aboriginal people and overseas commercial harvests (Kennett et al. 1997; Henry & Lyle, 2003). Indeed, genetic (mtDNA) information indicates that approximately 12% of the *C. mydas* taken in the Bali commercial turtle trade are from the Gulf of Carpentaria population (Dethmers & Broderick, 2003). Third, the accidental capture and drowning of sea turtles in discarded fishing nets has recently been revealed as a significant problem, indeed 205 turtles (including 36 *C. mydas*) were found entangled in nets that washed ashore in north-east Arnhem Land between 1996 and 2002 (Kiessling, 2003). A concerted effort addressing genetic analysis of these entangled turtles needs to be taken to reveal more about which nesting populations are at risk from this impact, and provide a baseline for management.

OTHER THREATS TO LOCAL NESTING POPULATIONS. We observed very little depredation of turtle eggs or hatchlings at any of the locations. However, we assume that depredation by birds could occur at some level because bird species previously recorded foraging on flatback hatchlings at other locations in northern Australia were observed on beaches in the SEP e.g. Pied Oyster Catchers (*Haematopus longirostris*), Beach Thick Knees (*Esacus neglectus*), Silver Gulls (*Larus novaehollandiae*), and various raptor species (Limpus, 1973; Duncan Limpus pers. comm.). Other predators known to forage on eggs or hatchlings at Australian rookeries but not observed (or recorded by local inhabitants) on these islands are wild pigs (*Sus scrofa*), rats (*Ratus ratus*), foxes (*Vulpes vulpes*) and Dingoes (*Canis lupus dingo*). While small goannas (species unknown) have been sighted on at least one island (Vanderlin Island) they have not been recorded eating turtle eggs or hatchlings. Despite the presence of crocodiles (*Crocodylus porosus*) in the waters around these islands, we found no visible signs or anecdotal evidence to indicate that crocodiles feed on Sea turtles while they are ashore nesting. Of more concern are the wild dogs (*Canis lupus familiaris*) and feral cats (*Felis catus*) on West Island. While the dogs pose a current threat to nesting turtles, eat predation on sea turtle hatchlings poses a potential problem (see Seabrooke, 1989) and management initiatives should be directed towards monitoring, and if necessary eliminating, these mortality sources.

Although our data was collected during brief periodic visits to the islands, and across a large island group, they provide important additional baseline observations that may be combined with existing knowledge for the management of sea turtle populations in the Gulf of Carpentaria. Local Indigenous ranger groups or Aboriginal Resource Centres are in excellent positions to either manage projects or collaborate with other parties on projects that are geared towards developing an understanding of the biology and management of the natural resources within their environment. Priority areas for future sea turtle

work in the SEP could include: 1) identification of species composition and abundance of nesting females on the mainland beaches, North Island, Pearce Island and Urquhart Island; 2) quantification of hatchling production at the main location for each species; and finally 3) collaboration with GoC fishers to quantify likely mortalities of sea turtles in regional fisheries.

ACKNOWLEDGEMENTS

Funding for this project was obtained through a Coasts and Clean Seas grant to Peter Whitehead and R. Kennett from the Key Centre for Tropical Wildlife Management (KCTWM) and KCTWM/Centre for Indigenous Natural and Cultural Resource Management (CINCRM) respectively of Charles Darwin University. M. Hamann completed the field work associated with this project while employed as a Research Associate by the KCTWM and CINCRM. This project could not have been completed without the dedicated assistance of the following people and organisations, WWF-Darwin, Mabunji Aboriginal Resource Centre, Claudette Albert, Roger Albert, Josh Coates, Terrence Couper, Richard Dickson, Nancy FitzSimmons, Sylvia Francis, Archie Johnson, Steve Johnson, Megan McCann, Brian Simon, Thomas and Barbara Simon, Shirley Simon, Marc Wohling and the families living at Base Bay, Wathunga and West Island. This project was carried out under NTU Animal (A01014) and Human (H01024) ethics permits and a NTPWC permit (10834).

LITERATURE CITED

BAKER, R. 1999. Land is life: from bush to town, the story of the Yanyuwa people. (Allen & Unwin, Australia).

BRADLEY, J. 1997a. Li-anthawirriyarra, people of the sea. Yanyuwa relations with their marine environment. PhD thesis, Northern Territory University, Darwin.

1997b. How can a whitefella know it all? Indigenous science-western science and marine turtles. Pp 25–32. In, Kennett, R., Webb, A., Duff, G., Guinea, M. & Hill, G. (eds), Marine turtle conservation and management in northern Australia. Centre for Indigenous Natural and Cultural Resource Management and Centre for Tropical Wetlands Management. Northern Territory University, Darwin.

CHATTO, R. 1997. A preliminary overview of the locations of marine turtle nesting in the Northern Territory. Pp 33–36. In, Kennett, R., Webb, A., Duff, G., Guinea, M. & Hill, G (eds) Marine turtle conservation and management in northern Australia. Centre for Indigenous Natural and Cultural Resource Management and Centre for Tropical Wetlands Management. Northern Territory University, Darwin.

COGGER, H.G. 1968. Reptiles of the Pellew Islands. Minmag 19: 21–23.

COGGER, H.G. & LINDNER, D.A. 1969. Marine turtles in northern Australia. Australian Journal of Zoology 15: 150–159.

CRUZ, B.J. & FRAZIER, J. 2000. More on error taboos: counting eggs and egg shells. Pp. 44–46. In Abreu-Grobois, F.A., Briseno-Duenas, R., Marquez, R. & Sarti, L (eds) Proceedings of the Eighteenth International Sea Turtle Symposium. US Dept. of Commerce. NOAA Technical Memorandum NMFS-SEFSC-436, 293.

DETHMERS, K. & BRODERICK, D. 2003. Green turtle fisheries in Australasia: Assessing the extent of their impact using mtDNA markers. Pp 41–44. In: Proceedings of the Twenty Second International Sea Turtle Symposium, Miami 2002. US Dept. of Commerce. NOAA Technical Memorandum NMFS-SEFSC-503.

ENVIRONMENT AUSTRALIA, 1998. Draft recovery plan for marine turtles in Australia. Department of Environment Australia, Canberra.

GUINEA, M. 1994a. Sea turtles of the northern territory. Pp 15–21. In, James, R. (ed.), Proceedings of the marine turtle conservation workshop. Sea World Nara Resort, Gold Coast, 14–17 November 1990. Australian Nature Conservation Agency, Canberra.

1994b. Nesting seasonality of the Flatback Sea Turtle *Natator depressus* (Garman) at Fog Bay, Northern Territory. Pp 150–153. In, James, R. (ed.) Proceedings of the marine turtle conservation workshop. Sea World Nara Resort, Gold Coast, 14–17 November 1990. Australian Nature Conservation Agency, Canberra.

HENRY, G.W. & LYLE, J.M. (eds), 2003. The National Recreational and Indigenous Fishing Survey, FRDC project No. 99/158.

KIESSLING, I. 2003. Finding solutions, derelict fishing gear and other marine debris in northern Australia. National Oceans Office, Darwin.

KENNETT, R., MUNUNGURRITJ, N. & YUNUPINGU, D. 1997. The Dhumurru miyapuna project. Pp. 69–76. In, Kennett, R., Webb, A., Duff, G., Guinea, M. & Hill, G. (eds) Marine turtle conservation and management in northern Australia. Centre for Indigenous Natural and Cultural Resource Management and Centre for Tropical Wetlands Management. Northern Territory University, Darwin.

LIMPUS, C.J. 1973. Avian predators of sea turtles in south-east Queensland rookeries. The Sunbird 4: 45–51.

1985. A study of the loggerhead turtle, *Caretta caretta* in eastern Australia. PhD thesis, The University of Queensland: Brisbane.

1992. Estimation of tag loss in marine turtle research. Wildlife Research 19: 457–469.

LIMPUS, C.J. & REED, P.C. 1985. Green sea turtles stranded by cyclone Kathy on the south-western coast of the Gulf of Carpentaria. Wildlife Research 12: 523–533.

LIMPUS, C.J. & NICHOLLS, N. 1988 The southern oseillation regulates the annual numbers of green turtles (*Chelonia mydas*) breeding around northern Australia. Australian Wildlife Research 15: 157–162.

2000. ENSO Regulation of Indo-Pacific Green Turtle Populations. Pp 399–408. In, Hammer, G.L. (ed.), The Australian Experience. Kluwer Academie Publishers.

MILLER, J.D. 1999. Determining clutch size and hatching success. Pp 124–129. In, Eckert, K., Bjorndal, K.A., Abreu Grobois, F.A. & Donnelly, M. (eds), Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine turtle specialist group publication No. 4.

PARADICE, W.E.J. 1924. The Sir Edward Pellew group of Islands: report with special reference to biology and physical features. Australian Commonwealth Parliamentary Report General Session 1923–24, 143: 1–20.

SCHÄUBLE, C.S. 2002. Establishment of a marine turtle database for Kakadu National Park, 2002. Pp 1–46 Unpub. report to Environment Australia, Kakadu National Park.

SEABROOK, W. 1989. Feral cats (*Felis catus*) as predators of hatchling green turtles (*Chelonia mydas*). Journal of Zoology 219: 83–88.

SCHROEDER, B.A. & MURPHY, S. 1999. Population surveys (ground and aerial) on nesting beaches. Pp 45–55. In, Eckert, K., Bjorndal, K.A., Abreu Grobois, F.A. & Donnelly, M. (eds), Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine turtle specialist group publication No. 4.

VANDERLAY, R. 1997. Nesting ecology of flatback sea turtles of West Alligator Head and Field Island, Kakadu National Park. Ms thesis, Northern Territory University, Darwin.

PSELAPHINAE (COLEOPTERA: STAPHYLINIDAE) OF NEW CALEDONIA AND LOYALTY ISLANDS. 1. *TAOMICA*, NEW GENUS OF PSELAPHINI AND A CATALOGUE OF PSELAPHINAE

PETER HLAVÁČ, GEOFF B. MONTEITH AND GEJZA DUNAY

Hlaváč, P., Monteith, G.B. & Dunay, G. 2006 11 10: The Pselaphinae (Coleoptera: Staphylinidae) of New Caledonia and the Loyalty Islands. 1. *Taomica*, new genus of Pselaphini and a catalogue of Pselaphinae. *Memoirs of the Queensland Museum* **52**(1): 79-86.

A remarkable new genus and species of Pselaphini, *Taomica cassani* Hlaváč, from the mainland of New Caledonia in the south-west Pacific, is described and illustrated. This is the first record of the tribe from New Caledonia. An annotated catalogue of the Pselaphinae recorded from New Caledonia and the Loyalty Islands (7 genera, 14 species) is also provided. ❐ *Staphylinidae, Pselaphinae, Pselaphini, new genus, new species, New Caledonia, catalogue.*

Peter Hlaváč, Na doline 14, SK-040 14, Košice, Slovakia, (email: hlavacp@stonline.sk); Geoff Monteith, Queensland Museum, PO Box 3300, South Brisbane Qld 4101, Australia (email: geoff.monteith@qm.qld.gov.au); Gejza Dunay, Královce 126, SK-044 44, Košice, Slovakia, (email: hadesia@stonline.sk); 17 February 2006.

The two archipelagos of New Caledonia (including the large main island or 'grande terre', Isle of Pines and Belep) and the Loyalty Islands (including Ouvéa, Lifou and Maré) lie closely adjacent in the SW Pacific (Fig. 1). The Pselaphinae of this region are poorly known and have not been studied for many years. The first papers dealing with the fauna were published in the 19th Century (Montrouzier, 1864; Raffray, 1896) and described 5 species in 3 genera of the supertribe Goniaceritae. Fauvel (1903) published a large paper on the Coleoptera of New Caledonia and added 6 new species in 2 genera of Goniaceritae, and a new monotypic genus in the tribe Tyrini of the supertribe Pselaphitae. For the next 50 years nothing further was written on the area's pselaphine fauna until Park (1952) described a new species of the supertribe Eupleetitae in a contribution devoted mostly to the Fiji Islands. Thus, to date, only 13 species and 6 genera are known from New Caledonia and the Loyalties, and the present paper is the first to deal with the taxonomy of the fauna for 54 years.

It is obvious that such a large and tropical area must house a much higher diversity of Pselaphinae than the taxonomic literature indicates. Fogging of the forest canopy at several sites in New Caledonia showed that Pselaphinae comprised up to 7.9% of individuals of all Coleoptera sampled (Guilbert et al., 1994), and in another study Guilbert et al. (1995) noted that 'Pselaphidae are more abundant in our samples than in any other published (canopy) results'. A recent survey by the Queensland Museum of a small area at the southern tip of New Caledonia revealed 48 pselaphine species (Monteith et al., 2006). Good collections of New Caledonian Pselaphinae are now available and it is clear that the fauna is highly diverse and contains many new genera and species. The aim of the senior author is to revise the fauna of New Caledonia and the Loyalties in future years, and this paper makes a start by describing a striking new genus of Pselaphini and presenting a catalogue of the described species.

CONVENTIONS

The following abbrevations and symbols are used through the text: MNHN, Muséum National d'Histoire Naturelle, Paris, France; QM, Queensland Museum, Brisbane, Australia; TL, type locality; p (printed), h (hand-written), / (used to separate different labels). For nomenclatural purposes the sole author of the new taxa is the senior author.

Taomica Hlaváč, gen. nov.
(Fig. 2A-E)

ETYMOLOGY. The name is taken from Mt Taom, the type locality. Gender female.

TYPE SPECIES. *Taomica cassani* Hlaváč sp. nov.

DIAGNOSIS. The genus is preliminarily placed in the tribe Pselaphini by the presence of single tarsal claws, although in general appearance it

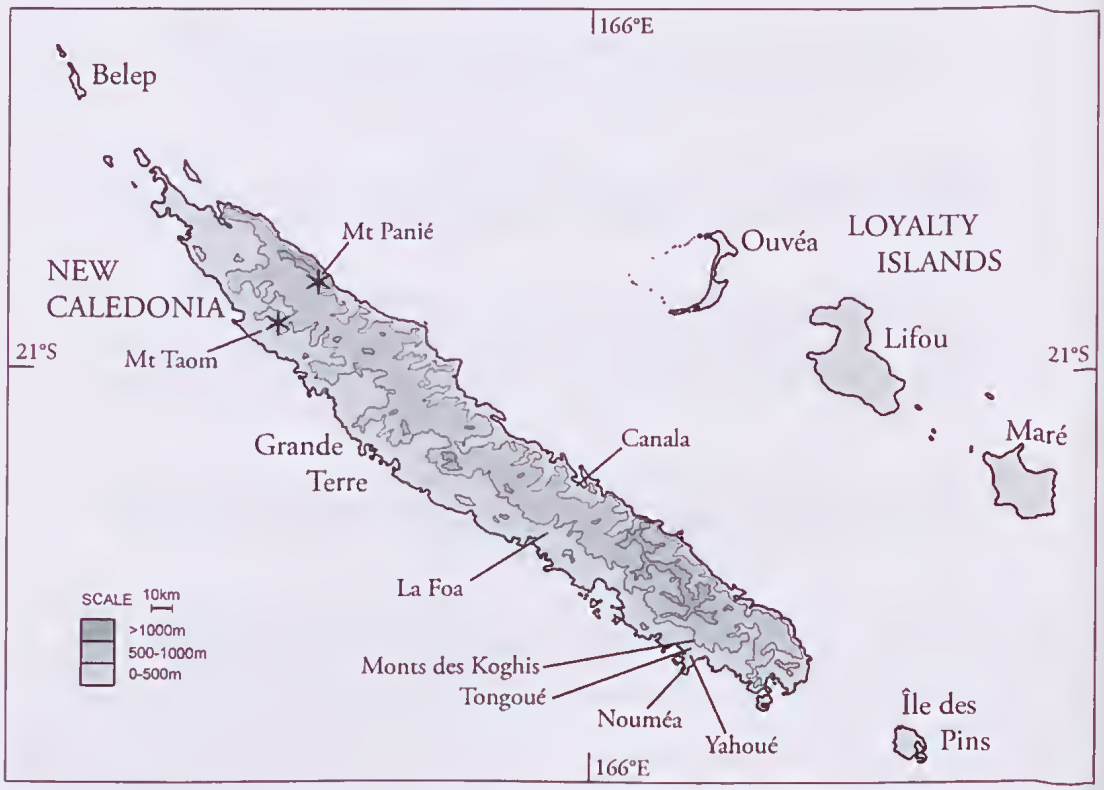


FIG. 1. Map of New Caledonia showing localities for *Taomica cassani* gen. et sp. nov. (*) and other localities from which pselaphine species have been recorded in the catalogue.

more closely resembles members of the tribe Tyrini. *Taomica*, due to the strange development of maxillary palpi, the presence of two pairs of long, acute spines on the ventral side of head, and the presence of a single basal fovea on each elytron, is strongly isolated within the tribe and this distinctive genus cannot be placed near any other at this time. Further important generic characters are as follows: frontal fovea absent; two setose foveae on vertex; eyes large; maxillary palpi very characteristic, segment II curved basally and IV extremely large, curved, machete-like; pronotum with minuscule antebasal median and lateral foveae; antebasal sulcus absent; elytron with sutural stria well defined along entire length; tergite III distinctly longer than tergites IV-VIII combined, with two large setose basal depressions.

DESCRIPTION. *Body*. Elongate (Fig. 2A), shiny, with golden pubescence, elytra widest at apex. Head longer than wide, hexagonal, widest at level of eyes, evenly narrowed anteriorly and posteriorly, shiny and densely pubescent; frontal fovea absent; vertexal foveae well defined and setose; frons strongly bilobed; frontal lobe large and deep prolonged into large channel; lateral frontal carinae present; suprantennal prominences well defined; tempora straight; eyes large; maxillary palpi (Fig. 2C) with segment I minuscule, II long and strongly curved basally, III small and triangular, IV flat, large and long, larger than II, curved, machete-like, terminal segment V absent; ventral part of head (Fig. 2C) with 2 pairs of long and acute spines on each side, and with 2 large depressions, neck entirely covered with squamous setae.

Antennae. 11-segmented, extending beyond basal margin of pronotum, finely tuberculate and evenly pubescent; club weakly formed by 1 segment and weakly defined, about as long as scape; scape more than twice as long as wide, distinctly longer than pedicel; segments II-X elongate and symmetrical.

Pronotum. Almost spherical, shiny with very fine, sparse punctation, naked on disc and densely pubescent at sides; median antebasal and lateral

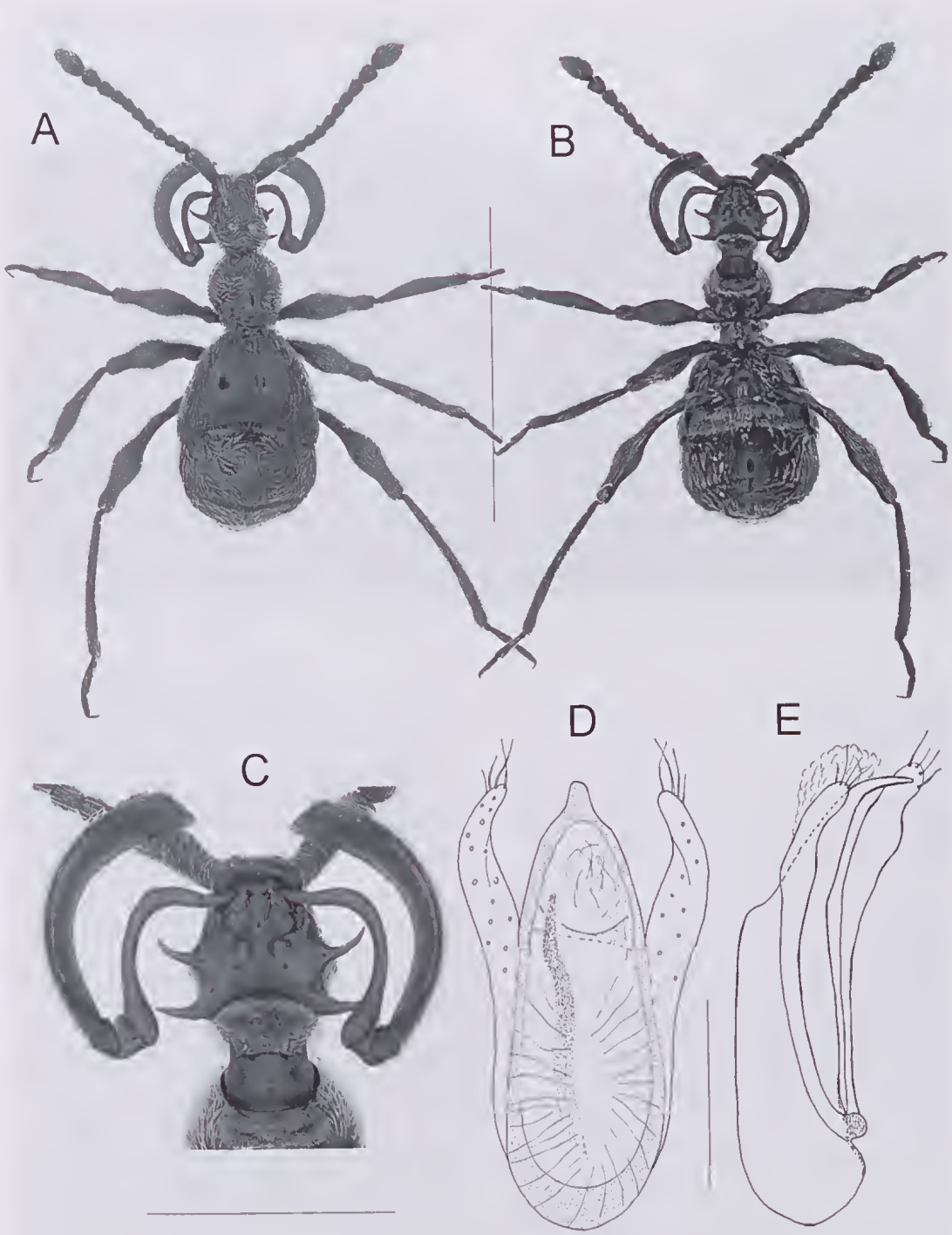


FIG. 2. A-E, *Taomica cassani* gen. et sp. nov. A-B, holotype ♀, scale bar, 2mm; A, dorsal view; B, ventral view; C, holotype ♀ head, ventral view, scale bar, 1mm; D-E, aedeagus, scale bar, 0.5mm; D, dorsal view; E, lateral view.

FIG. 3. Summit area of Mt Taom. The type locality of *Taomica cassani* is the small relict patch of rainforest indicated by the arrow. The absolute summit of the mountain is also indicated. The vehicle tracks visible are made by prospectors for nickel ore. The tall, dark trees are the native conifer, *Araucaria montana*.

foveae minuscule but well defined; antebasal suleus absent; ventral pronotum (Fig. 2B) with anterior part covered with squamous setae, sides shiny with long, golden setae. Mesosternum small, anterior part with squamous setae, sides shiny with long, golden setae. Metasternum about 3 times as wide as long, lacking foveae, middle with shallow, oval depression; apex of metasternum broadly truncate.

Elytra. Shiny with very fine and sparse punctulation; setae lacking on dise and sides densely pubescent; elytra strongly triangular, 5 (♂) or 6 (♀) times as wide at apex as at base, each elytron with a basal, sutural fovea prolonged into sutural stria reaching apex of elytron.

Abdomen. Slightly convex, all visible tergites shiny, almost glabrous, apex of each tergite with long, golden setae; tergite III very long, distinctly longer than IV-VIII together, with two large, basal, setose depressions; paratergites well developed; all visible tergites lacking carinae. Abdominal sternites (Fig. 2B): III narrow, with large, long sternal process, base entirely covered with two lines of squamous setae; IV-VIII shiny with long, sparse, golden setae; IV largest, about as long as V-VIII combined.

Legs. Long and slender; femora clavate, simple; no spines on femora or trochanters.

Sexual Dimorphism. Both sexes very similar; female more robust, with wider mesotibiae, and simple apices of metatibiae that bear apical spurs in male.

Taomica cassani Hlaváč, sp. nov.
(Fig. 2A-E)

ETYMOLOGY. The species is named after Jean Jerome Cassan, Environment Officer with the Province Nord government, who kindly arranged access to the habitat on the summit of Mt Taom, type locality of the species.

MATERIAL. HOLOTYPE ♂: (p) NEW CALEDONIA, 11960, 20°47'S × 164°35'E, 980m, Mt Taom summit, Site 1, 4 Jan 2005, G.B. Monteith, Berlesate, sieved litter, RF./red label (p) HOLOTYPE *Taomica cassani* sp. nov., P. Hlaváč des., 2006. (MNHN). PARATYPE ♀: (p) NEW CALEDONIA 8764, 20°34'S x 164°46'E, Mt Panié refuge, 1300m, 8-9 Nov 2001, C. Burwell, Pyrethrum, trees & logs/red label (p) PARATYPE *Taomica cassani* sp. nov., P. Hlaváč des., 2006. (QM).

DESCRIPTION. *Body.* (Fig. 2A) Shiny, reddish-brown, elongate. Measurements (mm): length/combined width of elytra at apex/combined width of elytra at base, ♀: 3.42/1.35/0.26; ♂:

3.26/1.15/0.24; antennae, maxillary palpi and legs similar in colour to rest of body.

Head. Elongate, hexagonal, at level of eyes about 0.75 times as wide as long, from eyes evenly narrowed anteriorly and posteriorly, shiny and densely pubescent; tempora straight, almost twice as long as diameter of eyes; maxillary palpi very large, with unusually shaped segments II and IV as in Fig. 2C; venter of head with two pairs of large, acute laterally-projecting spines that are clearly visible dorsally.

Antennae. With scape about 2.7 times as long as wide and about 3.2 times as long as pedicle; pedicle almost transverse; segments III-VIII subequal in size; segment IX longer and larger, 1.25 times as long as wide; segment X about 1.5 times as long as wide, symmetrical; terminal segment more than twice as long as wide and about same length as scape, relative lengths of antennal segments from basal to apical: 23: 6: 8: 8: 8: 8: 8: 8: 10 12: 24.

Pronotum. About as long as wide. Abdominal tergite III 5 times as long as tergite IV and about 4 times as long as IV-VIII combined; tergite III with two large, setose depressions extending almost the entire basal width of tergite. Elytra triangular, apical corners prolonged and sharply rounded. Abdomen about as wide as elytra at apex.

Aedeagus. (Fig. 2D-E) Symmetrical in dorsal view, elongate and evenly narrowed apically, pointed at apex; internal sac with well defined elongate spine; parameres elongate, symmetrical.

Sexual Dimorphism. As for the genus and with antennal segment X in female about as long as wide, asymmetrical, about 1.7 times wider at apex than at base; terminal antennal segment 1.9 times as long as wide, slightly shorter than scape.

DISTRIBUTION AND HABITAT. (Figs 1, 3-4) The main island of New Caledonia is elongate, about 400km long and 50km wide and oriented from the NW to SE in the SW Pacific Ocean. An irregular series of mountains runs the length of the island and these greatly affect rainfall patterns. South-easterly winds blow off the sea bringing rain which falls largely on the east coast and adjacent mountains. The western half of the island lies in the rainshadow of the mountains and receives very reduced rainfall. For this reason most rainforest lies on the eastern side

FIG. 4. Dense rainforest, locality of *Taomica cassani* gen. et sp. nov. paratype at 1,300m on the east face of Mt Panié. The area lies within a special botanical reserve.

of the island, while the west is covered with heaths, savannas and sclerophyll forests. The highest (1,629m) and wettest mountain on the island is Mt Panié which lies very close to the east coast at 20°34'S, about 90km south of the northern tip of the island. The mountain is covered with luxuriant rainforest and the only walking track to the summit starts from the coast on the east side and passes via a refuge hut at 1300m. The paratype of *Taomica cassani* was taken by pyrethrum spraying of mossy logs and tree trunks near that refuge hut. The forest at that point is very diverse, with many primitive conifers such as *Agathis* and *Araucaria* and a dense understorey of palms, *Pandanus* and other plants (Fig. 4). The holotype specimen was collected by Berlese funnel extraction of sifted leaf-litter from near the summit of Mt Taom (1,092m) which is 30km south of Mt Panié. Mt Taom is the the highest point of the Ouazangou-Taom Massif (length 30km), which is one of a series of isolated mountain massifs which parallel the north west coast of New Caledonia. These massifs have low rainfall because they are in the rainshadow of the higher eastern mountains and their vegetation is mostly the low, sclerophyllous, fire-induced heath known as 'maquis'. This contrasts strongly with the habitat on Mt Panié, but at several favourable sites near the summit of Mt Taom small patches of stunted rainforest survive, supported by orogenic fogs and mists which occur mostly at night. The holotype was collected from Monteith's 'Site 1' rainforest patch which is only about 2 hectares in size and lies at 980m, 1km WNW of the absolute summit of Mt Taom (Fig. 3). A new flightless scarabacine dung beetle seems to be restricted to the same rainforest patches (Monteith, pers. obs.). These records indicate the importance of these tiny patches of rainforest as refuges for fauna more typical of the wet eastern mountains. Mt Taom is difficult to visit because the only access is via a private road, operated by a company mining nickel at the western end of the mountain, followed by a walk of 5km.

ANNOTATED CATALOGUE OF PSELAPHINAE OF NEW CALEDONIA AND LOYALTY ISLANDS

EUPLECTITAE

Placodium Broun, 1893: 1431. Type species: *Placodium zenarthrum* Broun, 1893 by monotypy. Distribution: New Zealand, New Caledonia.

P. remingtoni Park, 1952: 14 (*Placodium*, TL: 7 miles south-east La Foa, under bark of a tree).

GONIACERITAE

Anasopsis Raffray, 1904: 179. Type species: *Anasis savesi* Raffray, 1896, designated by Newton & Chandler 1989: 42. Distribution: New Caledonia.

A. adumbrata Raffray, 1896: 300 (*Anasis*, TL: Loyalty Islands, Maré). Distribution: Loyalty Islands, New Caledonia (Monts des Koghis).

A. aubei Montrouzier, 1864: 92 (*Ticlus* (sic), TL: Canala). Distribution: New Caledonia (Canala, Monts des Koghis). = savesi Raffray, 1896: 300 (Anasis, TL: Monts des Koghis). Note: Fauvel (1903: 281) incorrectly placed *A. aubei* as a junior synonym of *A. savesi* due to Montrouzier's inadequate description. According to the ICZN rules of priority the valid name of the species must be *A. aubei* with *A. savesi* its junior synonym.

A. distans Fauvel, 1903: 282. (*Anasis*, TL: Monts des Koghis and Tonghoué). Distribution: New Caledonia (Monts des Koghis, Tonghoué).

Baraxina Raffray, 1896: 301. Type species: *Baraxina francoisi* Raffray, 1896 by monotypy. Distribution: New Caledonia.

B. francoisi Raffray, 1896: 301 (*Baraxina*, TL: Nouméa).

Eupines King, 1866: 309. Type species: *Bryaxis clavatula* King, 1864, designated by Jeannel, 1952: 84. Distribution: Oriental region, New Guinea, Australia, New Zealand, New Caledonia.

E. caledonica Raffray, 1896: 302 (*Eupines*, TL: Nouméa).

E. spinifera Fauvel, 1903: 283 (*Eupines*, TL: Nouméa).

E. suturalis Fauvel, 1903: 284 (*Eupines*, TL: Tonghoué).

E. trapezus Fauvel, 1903: 284 (*Eupines*, TL: Nouméa).

E. villosula Raffray, 1896: 283 (*Eupines*, TL: Nouméa).

Physoplectus Reitter, 1882: 210. Type species: *Euplectus armipes* Raffray, 1882 by subsequent monotypy Reitter, 1885: 338. Distribution: Japan, Mauritius, Reunion, Somalia, Society Islands, New Guinea, Australia, New Caledonia.

P. homaliinus Fauvel, 1903: 280 (*Amauronyx*, TL: Nouméa).

PSELAPHITAE

Anagomus Fauvel, 1903: 284. Type species: *Anagomus fracticornis* Fauvel, 1903 by monotypy. Distribution: New Caledonia. ***A. fracticornis*** Fauvel, 1903: 285 (*Anagomus*, TL: Yahoué).

Taomica Hlaváč, gen. nov. Type species: *Taomica cassani* Hlaváč, sp. nov. by original designation. Distribution: New Caledonia.

T. cassani Hlaváč, sp. nov. (*Taomica*, TL: Mt Taom summit).

DISCUSSION

In the catalogue of species above, spellings in the early literature of the localities 'Mont Kogui' and 'Kanala', have been changed to the modern spellings of Monts des Koghis and Canala, respectively. All localities from which Pselaphines have been recorded in the above catalogue are shown in Fig. 1.

It is well known that New Caledonia has a highly endemic fauna (Chazeau, 1993) so it is not surprising that the New Caledonian Pselaphinae fauna also has a very high degree of endemism. All 14 described species are endemic to New Caledonia and all are present on the main island (Grande Terre). Only one of these species, *Anasopsis adumbrata* Raffray, also occurs elsewhere; on Maré in the nearby Loyalty Islands. Of the 7 recorded genera, 4 are endemic to New Caledonia and the Loyalties (*Anagomus*, *Baraxina*, *Anasopsis* and *Taomica*). *Eupines* (136 described spp.) and *Physoplectus* (8 described spp.) are widely distributed in the Oriental and Australian region (Newton & Chandler, 1989) while *Placodium* has one species in New Caledonia and one in New Zealand.

ACKNOWLEDGEMENTS

Our thanks go to Al Newton, Chicago, who kindly provided data from his database on Staphyliniformia as well for his continuous support to the first author in his studies of Staphylinidae. We also thank Jean Jerome Cassan, Environment Officer of the Direction du Développement Economique et de l'Environnement, Province Nord for his help to the second author during field work in New Caledonia.

LITERATURE CITED

BROUN, T. 1893. Manual of the New Zealand Coleoptera. Parts V, VI, VII. (S. Costall: Wellington). Pp. xvii + 975-1504.

CHAZEAU, J. 1993. Research on New Caledonian terrestrial fauna: achievements and prospects. Biodiversity Letters 1: 123-129.

FAUVEL, A. 1903. Faune analytique des Coléoptères de la Nouvelle-Calédonie. Revue d'Entomologie 22: 203-378.

GUILBERT, E., BAYLAC, M. & NAJT, J. 1995. Canopy arthropod diversity in a New Caledonian primary forest sampled by fogging. Pan-Pacific Entomologist 71: 3-12.

GUILBERT, E., CHAZEAU, J. & BONNET DE LARBOGNE, L. 1994. Canopy arthropod diversity of New Caledonian forests sampled by fogging: preliminary results. Memoirs of the Queensland Museum 36: 77-85.

JEANNEL, R. 1952. Psélaphides de Saigon. Revue Française d'Entomologie 19: 69-113.

KING, R.L. 1864. On the Pselaphidae of Australia. 2nd Paper. Transactions of the Entomological Society of New South Wales 1: 102-106.

1866. On the Pselaphidae of Australia. No. IV. Transactions of the Entomological Society of New South Wales 1(1865): 299-315.

MONTEITH, G.B., BURWELL, C.J. & WRIGHT, S. 2006. Inventaire de l'Entomofaune de Quatre Reserves du Sud de la Nouvelle Calédonie. Queensland Museum, unpubl. report to Direction des Ressources Naturelles, Nouméa., 136 pp, plus appendix.

MONTROUZIER, X. 1864. Perroud, B.-P. & Montrouzier, X. Essai sur la faune entomologique de Kanala (Nouvelle Calédonie) et description de quelques espèces nouvelles ou peu connues. Annales de la Société Linnéenne de Lyon (N.S.) 11: 46-257.

NEWTON, A.F., JR. & CHANDLER, D.S. 1989. World catalog of the genera of Pselaphidae (Coleoptera). Fieldiana: Zoology (N.S.) 53: iv + 93.

PARK, O. 1952. Pselaphidae of Oceania, with special reference to the Fiji Islands. Bernice P. Bishop Museum Bulletin 207: i-iii + 1-60.

RAFFRAY, A. 1896. Psélaphides d'Océanie récoltés par M. Ph. François (Col.). Bulletin de la Société Entomologique de France 65: 299-303.

1904. Genera et catalogue des Psélaphides (continued). Annales de la Société Entomologique de France 73: 1-400.

REITTER, E. 1882. Versuch einer systematischen Eintheilung der Clavigeriden und Pselaphiden. Verhandlungen des Naturforchenden Vereines in Brünn 20: 177-211.

1885. Abbildungen und Bemerkungen zu wenig gekannten Pselaphiden-Gattungen mit Beschreibungen neuer Arten. Deutsche Entomologische Zeitschrift 29(2): 333-339.

REVIEW OF *POLYRHACHIS (CYRTOMYRMA)* FOREL (HYMENOPTERA: FORMICIDAE: FORMICINAE) OF AUSTRALIA, BORNEO, NEW GUINEA AND THE SOLOMON ISLANDS WITH DESCRIPTIONS OF NEW SPECIES

RUDOLF J. KOHOUT

Kohout, R.J. 2006 11 10: Review of *Polyrhachis (Cyrtomyrma)* Forel (Hymenoptera: Formicidae: Formicinae) of Australia, Borneo, New Guinea and the Solomon Islands with descriptions of new species. *Memoirs of the Queensland Museum* **52**(1): 87-146. Brisbane. ISSN 0079-8835.

Thirty new species of the subgenus *Cyrtomyrma* are described, including nine from Australia: *P. abbreviata* sp. nov., *P. brevinoda* sp. nov., *P. decumbens* sp. nov., *P. delecta* sp. nov., *P. expressa* sp. nov., *P. hoelldobleri* sp. nov., *P. monteithi* sp. nov., *P. robsoni* sp. nov. and *P. rutila* sp. nov.; six from Borneo: *P. achterbergi* sp. nov., *P. bruehli* sp. nov., *P. danum* sp. nov., *P. lepida* sp. nov., *P. sulang* sp. nov. and *P. widodoi* sp. nov.; twelve from New Guinea: *P. aporema* sp. nov., *P. barryi* sp. nov., *P. conspicua* sp. nov., *P. dorsena* sp. nov., *P. hybosa* sp. nov., *P. inducta* sp. nov., *P. inflata* sp. nov., *P. integra* sp. nov., *P. kyawthani* sp. nov., *P. sedlaceki* sp. nov., *P. strumosa* sp. nov. and *P. tuberosa* sp. nov., and three from the Solomon Islands: *P. pacifica* sp. nov., *P. setosa* sp. nov. and *P. undulata* sp. nov. Seven subspecies, *P. laevissima arnensis* Viehmeyer, *P. rastellata celebensis* Viehmeyer, *P. rastellata corporaali* Santschi, *P. rastellata fulakora* Mann, *P. rastellata johnsoni* Mann, *P. rastellata nomo* Donisthorpe and *P. rastellata semiinermis* Donisthorpe are raised to specific status. A neotype of *P. australis* is designated. Two species, *P. rastellata* (Latreille) and *P. debilis* Emery, previously listed from Australia, apparently do not occur there. Checklists and identification keys to the *Cyrtomyrma* species of Australia, Borneo, New Guinea and the Solomon Islands are provided. All the new species are illustrated and notes on their distribution and nesting habits provided. ❐ *Hymenoptera, Formicidae, Polyrhachis, Cyrtomyrma, new species, identification keys, distribution.*

Rudolf J. Kohout, Queensland Museum, PO Box 3300, South Brisbane 4101, Australia (email: kohout@powerup.com.au); 22 February 2006.

Cyrtomyrma is one of the relatively well defined subgenera of *Polyrhachis*. However, it is a taxonomically difficult group with many very similar species that are frequently confused and misidentified. This study began in 2001 as a review of the Australian species of *Cyrtomyrma*, primarily to provide taxonomic support for studies on their nesting habits being conducted by Simon Robson at James Cook University (Robson & Kohout, 2005). Examination of Australian material revealed several new species, particularly in the Wet Tropics region of north Queensland (Kohout, 2000). However, because of the close affinities of the Australian fauna with that of South East Asia, it soon became apparent that it was necessary to examine material from Borneo, Indonesia, New Guinea and the Solomon Islands. This resulted in the recognition of twenty-one extralimital new species which are related to Australian species, or are otherwise interesting. The close affinity between the Australian *Cyrtomyrma* fauna and that of Indonesia, New Guinea and the Solomon Islands is evident in a number of pairs of very similar species, for example (Australian species listed first): *P. australis* Mayr – *P. mondoi* Donisthorpe (New Guinea); *P. decumbens* sp. nov. – *P. nomo* Donisthorpe (New Guinea); *P. delecta* sp. nov. – *P. euryala* Fr. Smith (Indonesia); and *P. expressa* sp. nov. – *P. emeryana* Mann (Solomon Islands). The characters separating the species of each pair are constant, and I prefer to treat them as distinct species rather than isolated populations of the same species.

With a highly convex, dome-shaped and mostly very finely sculptured mesosoma, the majority of *Cyrtomyrma* species bear a superficial resemblance to some members of the *P. mucronata*-group of the subgenus *Myrmhopla* Forel. However, virtually all *Cyrtomyrma* species have a distinct posterolateral carina separating the gena from the ventral parts of the head, a character lacking in all known species of the *P. mucronata*-group. The two groups also differ in the configuration of the petiole. In *Cyrtomyrma* the petiole is scale-like and usually armed with four (or more rarely two) teeth or spines. In contrast, the petiole in *P. mucronata*-group species is columnar and armed with two, more-or-less horizontal, posteriorly directed spines that usually curve to the shape of the gaster. In addition, the petiole often bears a pair of short, intercalary teeth.

The pupae also differ between the two groups, being naked in all known *Cyrtomyrma* species (a character shared with members of the subgenus *Myrmatopa* Forel), and enclosed within cocoons in *P. mucronata*-group species. The species of both groups have similar nesting habits, building nests of silk and vegetation debris upon the leaves of various plants.

METHODS

Unlike other *Polyrhachis* ants, the cuticle of *Cyrtomyrma* species appears to be very thin and the body is highly prone to fracturing in preserved specimens. Damage to many specimens, including numerous types, is so excessive that they could not be confidently measured or identified. The same problem was encountered during specimen preparation for scanning electron microscopy. In spite of specimens being 'critical point' dried, the head, mesosoma and gaster of many cracked in the vacuum chamber during the coating process. However, where the damage did not affect the taxonomically important parts of the body, or the general appearance of the ant was not significantly distorted, such specimens were still used for illustrations.

Publication dates and the spelling of species epithets and authors' names follow Bolton (1995), except for the name of W. Karawajew, where the spelling used by the author himself (e.g. 1927 *etc*) has been followed. Where a holotype specimen is mentioned as 'unique', this infers that it was the only specimen available for description and no syntype or paratype specimens are known to exist. This study is principally based on the worker caste but notes are provided on associated queens.

The localities at which ants were collected by the Bishop Museum's collectors were checked against that institution's list of New Guinean localities (BPBM, 1966, unpublished). In some cases the latitude and longitude co-ordinates, or altitude, are only roughly approximate. The use of the words "Borneo", "New Guinea" or "Bismarck Archipelago" alone indicate the delimitation of these regions in a biogeographic sense regardless of current political boundaries. Similarly, the fauna of Bougainville Island is treated with that of the Solomons. Collectively they share a relatively homogenous group of species that is rather distinct from that of the Bismarck Archipelago and New Guinea.

ILLUSTRATIONS. Scanning electron micrographs were prepared with a Hitachi S-530 SEM, using gold coated specimens. Unless otherwise indicated, they represent specially selected paratypes (often from the same nest series as the holotype) of new species or critically compared specimens (mostly from type localities) of previously described species. Because fracturing repeatedly occurred in specimens of several species, the SEM micrographs are sometimes complemented or substituted by digital images. These were also used to illustrate types of previously described species and of some new species where insufficient material prohibited the use of specimens for coating. Digital photographs were prepared using a ProgRes 3012 scanning digital camera (Jenoptik) attached to Leica MZ16 stereomicroscope. All digital images were processed using Auto-Montage (Syncroscopy, Division of Synoptics Ltd, USA) software.

STANDARD MEASUREMENTS AND INDICES. Measurements and indices follow those of Kohout (1990: 499): TL, Total length (the necessarily composite measurement of the outstretched length of the entire ant measured in profile); HL, head length (the maximum measurable length of the head in perfect full face view, measured from the anterior-most point of the clypeal border or teeth, to the posterior-most point of the occipital margin); HW, head width (width of the head in perfect full face view, measured immediately in front of the eyes); CI, cephalic index (HW x 100/HL); SL, scape length (excluding the condyle); SI, scape index (SL x 100/HW); PW, pronotal width (greatest width of the pronotal dorsum); MTL, metathoracic tibial length (maximum measurable length of the tibia of the hind leg). All measurements were taken using a Zeiss SR stereomicroscope with an eyepiece graticule calibrated against a stage micrometer. All measurements are expressed in millimetres (mm).

ABBREVIATIONS. *Collectors*. BBL, B.B. Lowery; CJB, C.J. Burwell; DJC, D.J. Cook; GBM, G.B. Monteith; JLG, J.L. Gressitt; JPH, J.& P. Hasenpusch; RJK, R.J. Kohout; RWT, R.W. Taylor; SKR, S.K. Robson; TCM, T.C. Maa.

General. Bch, Beach; Ck, Creek; FP, Forest Park; Hmsd, Homestead; I., Island; Is, Islands; Mt, Mount; Mtn, Mountain; Mts, Mountains; NP, National Park; Pen., Peninsula; Pltn, Plantation; R., River; Ra., Range; Rd, Road; rf., rainforest; SF, State Forest; Stn, Station; Tbld, Tableland; w, worker/s; x-ing, crossing.

Institutions (with names of cooperating curators). AMNH, American Museum of Natural History, New York, U.S.A (Dr J. M. Carpenter); ANIC, Australian National Insect Collection, Canberra, Australia (Drs S.O. Shattuck, R.W. Taylor); BMNH - The Natural History Museum, London, U.K. (Dr Barry Bolton); BPBM - Bernice P. Bishop Museum, Honolulu, U.S.A. (K.T. Arakaki); IZUW - Institute of Zoology, University of Würzburg, Germany (Dr B. Hölldobler); JCUT - James Cook University, Townsville, Australia (Dr S.K. Robson); MCSN - Museo Civico di Storia Naturale 'Giacommo Doria', Genova, Italy (Drs R. Poggi, V. Raineri); MCZC - Museum of Comparative Zoology, Harvard University, Cambridge, U.S.A. (Dr S. Cover); MHNG - Muséum d'Histoire Naturelle, Geneva, Switzerland (Drs C. Besuchet, I. Löbl, B. Merz); MLAC - Natural History Museum of Los Angeles County, Los Angeles, U.S.A. (Dr R.R. Snelling); MNHN - Muséum National d'Histoire Naturelle, Paris, France (Dr J. Casevitz Weulersse); MNHU - Museum für Naturkunde, Humboldt-Universität, Berlin, Germany (Dr F. Koch, Ms A. Kleine-Möllhoff); NHMB - Naturhistoriseches Museum, Basel, Switzerland (Drs M. Brancucci, D.H. Burckhardt); NHMW - Naturhistoriseches Museum, Wien, Austria (Drs M. Fischer, S. Schödl); NMNH - National Museum of Natural History, Smithsonian Institution, Washington, DC, U.S.A. (Dr T.R. Schultz); NNML - Nationaal Natuurhistoriseh Museum, Leiden, The Netherlands (Dr Ing. C. van Achterberg); NRMS - Naturhistoriska Riksmuseet Stockholm, Sweden (Dr K-J Hedquist, F. Ronquist, B. Viklund); OXUM - Hope Entomological Collections, University Museum, Oxford, U.K. (Dr C. O'Toole); QM - Queensland Museum, Brisbane, Australia (Drs C.J. Burwell, G.B. Monteith); SNSD - Staatliche Naturhistorische Sammlungen, Museum für Tierkunde, Dresden, Germany (Drs R. Emmrich, U. Kallweit); UCDC - University of California, Davis, USA (Dr P. Ward); ITBC - Institute for Tropical Biology and Conservation, Kota Kinabalu, East Malaysia (Dr Maryati Mohamed).

SYSTEMATICS

Genus **Polyrhachis** Fr. Smith, 1857

Polyrhachis Fr. Smith, 1857: 58. Type species: *Formica bihamata* Drury, 1773 by original designation.

Subgenus **Cyrtomyrma** Forel, 1915

Cyrtomyrma Forel, 1915: 107 (as subgenus of *Polyrhachis* Fr. Smith); Emery, 1925: 207 (diagnosis); Donisthorpe, 1938: 246 (revision); Dorow, 1995: 21; Bolton 1995: 26. Type species: *Formica rastellata* Latreille, 1802 by original designation.

TAXONOMIC HISTORY

In 1867 Mayr published the first attempt to subdivide the genus *Polyrhachis*. He established six groups called 'turmae' which he later (1879) renamed 'gruppen'. One of these groups, 'Rastellata', containing *P. rastellata* (Latreille), *P. laevissima* Fr. Smith and *P. levior* Roger largely corresponded with the modern day concept of the subgenus *Cyrtomyrma* except that Mayr also included *P. micronata* Fr. Smith that is now placed in the *micronata* species-group of the subgenus *Myrmhopla* Forel. Emery (1896) accepted Mayr's system of 'gruppen', but reduced their number to four and named them 'coorti', with 'Coorte 2. *Polyrhachides carinatae*' divided into five 'manipuli', one of which, 'manipulus *rastellata*', corresponded with Mayr's 'Rastellata' group. Wheeler (1911) largely recognised Emery's four 'coorti' but formally named them as subgenera and added a fifth. Emery's '*Polyrhachides carinatae*' become the subgenus *Myrma* (sensu Wheeler, 1911). Forel (1915) further elaborated the classification of *Polyrhachis* by subdividing several of the subgenera established by Wheeler (1911). Forel (1915) removed several species from *Myrma* (corresponding to Emery's 'manipulus *rastellata* and 'manipulus *revoili*') and placed them within a new subgenus *Cyrtomyrma*. Forel named *P. rastellata* as the type species of *Cyrtomyrma*, but did not provide a description of the subgenus. In 1921, Emery removed *P. revoili* from *Cyrtomyrma* and placed it, with several other African species, into his newly established subgenus *Psendocyrtomyrma* Emery (later synomymised with *Myrma*). Emery (1925) gave the first diagnosis of *Cyrtomyrma* and included 10 species and 15 subspecific forms within the subgenus. The first attempted revision of *Cyrtomyrma* was published by Donisthorpe (1938) who treated 23 species and 9 subspecies. He divided the subgenus into two main groups based on the shape of the pronotal humeri. Each of these groups was subdivided into two subgroups according to the presence or lack of propodeal spines. More recently Dorow (1995) gave an overview of the higher classification of *Polyrhachis* and included keys to the subgenera. He also included diagnoses and lists of species for all the subgenera, together with notes on the their history, phylogeny and distribution. Bolton (1995) published the latest list of *Cyrtomyrma* species, including all available and unavailable

names, in his catalogue of world ants. The world fauna of *Cyrtomyrma* was revised by Than (1978) in his PhD thesis, but this work was not subsequently published. However, numerous 'type' specimens bearing his manuscript names have been distributed to several museums. These specimens have no nomenclatural status and should be ignored.

DIAGNOSIS

Worker. Relatively small ants (HL < 2.10) with general characteristics of the genus. Head relatively large, more-or-less triangular in frontal view, with sides moderately convex and anteriorly converging in front of eyes; behind eyes, sides of head rounded into broadly convex occipital margin; strong, longitudinal carina running from occipital corners towards mandibular bases and separating gena from ventral parts of head (carina absent in *P. achterbergi* sp. nov. and *P. widodoi* sp. nov.). Mandibular masticatory border with 5 teeth, apical tooth longest, subsequent teeth gradually reducing in length. Anterior clypeal margin in most species with central, truncate flange, usually notched medially and flanked by distinct angles or acute denticles (anterior clypeal margin deeply emarginate medially in *P. widodoi*; with a central, projecting blunt tooth in *P. achterbergi*); basal clypeal margin usually only moderately impressed, laterally indicated by a thin line. Eyes relatively large, ranging from flat to distinctly convex; ocelli mostly absent. Frontal carinae strongly sinuate in most species. Mesosoma moderately to strongly longitudinally and transversely convex, with dorsum totally immarginate. Pronotal humeri toothed, angular or simply rounded; promesonotal suture distinct, metanotal groove absent or weakly indicated by a faint line or slight depression in lateral outline. Propodeum armed with short spines, tubercles, or completely unarmed, descending into declivity in a more-or-less smooth, medially uninterrupted line. Petiole scale-like, usually armed with four spines or teeth of variable length and configuration, rarely with backwards directed, long and slender lateral spines (as in *P. sedlaceki* sp. nov.) or with all spines reduced to minute denticles (as in *P. semiinermis* Donisthorpe, *P. danum* sp. nov. and *P. brevinoda* sp. nov.). Gaster large, globose, first segment occupying about half its length. All body surfaces rather smooth (highly polished in *P. sedlaceki*), with sculpturation consisting mostly of very fine, superficial reticulations with scattered minute pits; sculpture becoming distinctly more coarsely reticulate laterally; a few species (*P. achterbergi*, *P. bruehli* sp. nov., *P. inflata* sp. nov., *P. luctuosa* Emery, *P. vitalisi* Santschi and *P. widodoi*) with head, mesosoma and petiole more heavily sculptured, reticulate-punctate, opaque. Colour of body mostly black, more rarely blue.

Queen. Similar to worker, with usual characters identifying full sexuality, including three ocelli and fully developed thoracic structure with wings. Armament of pronotal humeri markedly reduced; propodeal and petiolar spines distinctly shorter, but queens of some species (e.g. *P. robsoni* sp. nov.) with short propodeal spines that are completely absent in workers; sculpturation and colour virtually identical to worker.

Male. Males of many species are known, but their diagnosis is beyond the purpose and scope of this paper.

Distribution and biology. The known distribution of the subgenus ranges from China to India and Sri Lanka and south across Indonesia and New Guinea to the Solomon Islands and northern Australia. All known species are arboreal, building nests of silk and vegetation debris between the leaves and shrubs of trees. However, some species are occasionally lignicolous, using available cavities such as bamboo internodes or hollow branches, the walls of which they line with silk (Robson & Kohout, 2005). Some species (e.g. *P. inducta* sp. nov., *P. mondoi* Donisthorpe) have also been found nesting under bark on living trees.

INFRASPECIFIC TAXA ELEVATED TO SPECIFIC STATUS

As a result of examination of numerous types and other available material of species related to *P. laevissima* Fr. Smith and *P. rastellata*, I propose seven subspecies be elevated to specific status. Three that occur in areas outside the main geographic scope of this paper are treated below. The others are treated within their geographic provenance; one from New Guinea and three from the Solomon Islands.

Polyrhachis celebensis
Viehmeyer, 1913 stat. nov.

Polyrhachis rastellata var. *celebensis* Viehmeyer, 1913: 155. Syntype workers. Type locality: INDONESIA, SULAWESI (in copal), MNHU (examined).

Polyrhachis (Cyrtomyrma) rastellata var. *celebensis* Viehmeyer, Emery, 1925: 208; Donisthorpe, 1938: 256.

REMARKS. Following examination of both available syntypes, I consider *P. celebensis* to be

a distinct species from *P. rastellata*. *Polyrhachis celebensis* is characterised by angular pronotal shoulders armed with diminutive denticles, a petiole armed with four spines (the dorsal pair rather prominent and slightly longer than the lateral pair) and black legs. In contrast, the pronotal shoulders in *P. rastellata* are narrowly rounded, the petiolar spines subequal in length and the legs distinctly orange or light reddish-brown.

Polyrhachis corporaali
Santschi, 1928 stat. nov.

Polyrhachis (Cyrtomyrma) rastellata var. *corporaali* Santschi, 1928: 134, fig. 2. Syntype workers, queen. Type locality: INDONESIA, Sumatra, Medan (J.B. Corporaal), NHMB (examined).

REMARKS. *Polyrhachis corporaali* was described by Santschi as the 'smallest known variety of *rastellata*'. It is easily separated from that species by its much smaller size, distinctly toothed pronotal shoulders and closely approximated frontal carinae resulting in an extremely narrow central area.

Polyrhachis semiinermis
Donisthorpe, 1941 stat. nov.

Polyrhachis (Cyrtomyrma) rastellata var. *semi-inermis* Donisthorpe, 1941: 209. Syntype workers. Type locality: PHILIPPINES, Luzon, Baguio (A. Moore), BMNH (examined).

REMARKS. *Polyrhachis semiinermis* is characterised by widely rounded pronotal shoulders and a petiole that is virtually parallel-sided with the petiolar teeth reduced to mere denticles or completely lacking. Based on these characters, *P. semiinermis* is much more closely related to the newly described *P. danum* from Borneo and *P. brevinoda* from Australia than to *P. rastellata*.

CHECKLIST OF AUSTRALIAN SPECIES

Synonyms are indented with non-Australian junior synonyms excluded.

P. abbreviata sp. nov.
P. australis Mayr, 1870
  P. doddi Donisthorpe, 1938
  P. nox Donisthorpe, 1938
  P. townsvillei Donisthorpe, 1938
P. brevinoda sp. nov.
P. decumbens sp. nov.
P. delecta sp. nov.
P. expressa sp. nov.
P. hoelldobleri sp. nov.
P. mackayi Donisthorpe, 1938
P. monteithi sp. nov.
P. pilosa Donisthorpe, 1938
P. robsoni sp. nov.
P. rutila sp. nov.
P. yorkana Forel, 1915

Taylor & Brown (1985) and Kohout & Taylor (1990) included *P. rastellata* in their list of Australian species. However, following examination of *P. rastellata* specimens from India and Sri Lanka and their comparison with extensive material of Australian *Cyrtomyrma*, I am reasonably confident that *P. rastellata* does not occur in Australia.

Kohout (2000) also suggested *P. debilis* Emery occured in Queensland's Wet Tropics and more recently, similar specimens have been collected on Melville I. off the coast of the Northern Territory (A. Andersen, *pers. comm.*). However, direct comparison of these specimens with several syntypes of *debilis* (MCSN, MCZC, NMNH) has shown that they are not conspecific. Specimens from the Wet Tropics listed as *P. debilis* by Kohout (2000) are *P. yorkana* Forel (see below). Those from Melville I. probably represent a new species but there is insufficient material to describe it here. The type locality of *P. debilis* (Fly River, Papua New Guinea) is situated just across Torres Strait from Cape York Peninsula and a number of *Polyrhachis* species (e.g. *P. sexspinosa* (Latreille), *P. schenckii* Forel, *P. andromache* Roger, *P. brevinoda* sp. nov. and *P. decumbens* sp. nov.) occur in both areas. Despite the vast amount of *Cyrtomyrma* material available from Cape York Peninsula, I have not found any specimens satisfactorily comparable with the *P. debilis* syntypes. Consequently, until proven otherwise, I regard *P. debilis* as a New Guinean element not occuring in Australia.

KEY TO *CYRTOMYRMA* SPECIES FROM AUSTRALIA
(based on worker caste)

1. Pronotal shoulders in dorsal view more-or-less toothed or obtusely angular; greatest width of pronotal dorsum across, or just below shoulders (e.g. Figs 2I, 3G, 4B) 2

   Pronotal shoulders in dorsal view narrowly or widely rounded; greatest width of pronotal dorsum at, or about, middle of its length (e.g. Figs 2E, 2G, 4D) 7

2. Propodeum armed with a pair of spines, denticles or tuberculae (e.g. Figs 2H, 3D, 4A, 4G) 3

   Propodeum totally unarmed (Fig. 3F) . . *robsoni* sp. nov.

3. Dorsal surfaces of body covered with numerous relatively long, mostly erect or variously curved hairs (Fig. 3D) ..... *monteithi* sp. nov.

Dorsal surfaces of body with only a tuft of erect hairs on summit of mesosoma and a few hairs on dorsum of head and along apical segments of gaster (e.g. Figs 2H, 4A) 4

4. Propodeal spines well developed, generally longer than half distance between their bases (e.g. Figs 2F-G, 4A-B) ... 5

Propodeal spines much shorter than half distance between their bases or reduced to mere denticles or tuberculae (e.g. Figs 1D-E, 4G-H) 6

5. Pronotal shoulders distinctly toothed or bilobed (Fig. 2I); generally smaller (HL 1.40-1.47) .. *hoelldobleri* sp. nov.

Pronotal shoulders bluntly angular or narrowly rounded (Fig. 4B); generally larger (HL 1.53-1.72) ..... *australis* Mayr (in part)

6. Smaller (HL 1.25-1.34); propodeal spines short, but always present (Fig. 1D-E); legs distinctly yellow, or light reddish-brown ..... *abbreviata* sp. nov. (in part)

Larger (HL 1.56-1.62); propodeal spines very short or reduced to mere denticles or tuberculae (Fig. 4G-H); legs dark reddish-brown ..... *yorkana* Forel (in part)

7. Dorsal surfaces of body covered with numerous erect and/or decumbent hairs (e.g. Figs 1H, 4E) 8

Dorsal surfaces of body virtually without hairs, except for tuft of erect hairs on summit of mesosoma, a few hairs on dorsum of head and along apical segments of gaster (Figs 2D, 4A) 10

8. Pubescence of body consisting of abundant, short to very short, somewhat decumbent or recumbent hairs; only a few scattered longer, erect hairs present (Figs 1H-I, 3H-I) 9

Pubescence of body consisting of numerous, relatively long, erect or variously curved hairs, covering most dorsal surfaces; only sparse decumbent hairs present (Fig. 4E-F) ..... *pilosa* Donisthorpe

9. Body distinctly bicoloured, reddish-brown with gaster and appendages bright orange; mesosomal dorsum in lateral view distinctly impressed at promesonotal suture (Fig. 3H) ..... *rutila* sp. nov.

Body unicoloured, jet-black with appendages mostly medium to dark reddish-brown; mesosomal dorsum in lateral view evenly rounded, without distinct impression at promesosonal suture (Fig. 1H) ... *decumbens* sp. nov.

10. Propodeum armed with a pair of spines, denticles or tuberculae (e.g. Fig. 4A, G) 11

Propodeum totally unarmed (e.g. Figs 1F, 2D, 4C) . 14

11. Mesosomal dorsum in lateral view distinctly flat or shallowly impressed at promesonotal suture (Fig. 2F) ..... *expressa* sp. nov.

Mesosomal dorsum in lateral view evenly convex, without distinct impression at promesonotal suture (Figs 4A, 4G) 12

12. Lateral petiolar spines distinctly longer than dorsal pair; propodeal spines generally longer than half distance between their bases (Fig. 4A-B) .. *australis* Mayr (in part)

Lateral petiolar spines only slightly longer than dorsal pair, or all spines subequal; propodeal spines shorter than half distance between their bases (e.g. Figs 1D-E, 4G-H) 13

13. Propodeal spines short, but always present (Fig. 1D-E); legs distinctly yellow, or light reddish-brown ..... *abbreviata* sp. nov. (in part)

Propodeal spines very short, present as strongly upturned denticles or more-or-less distinct tuberculae (Fig. 4G); legs dark reddish-brown ..... *yorkana* Forel (in part)

14. Petiole virtually parallel-sided; petiolar spines very short, lateral spines reduced to denticles (Fig. 1G) ..... *brevinoda* sp. nov.

Petiole with sides diverging dorsally; lateral petiolar spines at least as long as dorsal pair (Figs 2E, 4D) 15

15. Antennal scapes longer (SI >140); lateral petiolar spines distinctly longer than dorsal pair (Indonesia) ..... (*euryala* Fr. Smith)

Antennal scapes shorter (SI <135); lateral and dorsal petiolar spines subequal in length 16

16. Pronotum in dorsal view strongly transverse, with humeri narrowly rounded or weakly angulate (Fig. 4D); petiole with sides only weakly diverging dorsally, spines shorter (Fig. 4C) (mid- to southern Queensland) ..... *mackayi* Donisthorpe

Pronotum in dorsal view weakly transverse, with humeri widely rounded (Fig. 2E); petiole with sides more strongly diverging dorsally, spines longer (Fig. 2D) (far north Queensland) ..... *delecta* sp. nov.

Polyrhachis abbreviata sp. nov.
(Fig. 1A, D-E)

MATERIAL. HOLOTYPE: QUEENSLAND, Mission Beach, e. 4km WbyS of, 17°53'S, 146°04'E, 29.ii.1996, lowland rf., ex silk nest between leaves, S.K.A. Robson #253 (worker). PARATYPES: data (and nest) as for holotype (157 workers, 1 dealate ♀). Type deposition: Holotype (QMT99331), most paratype workers and paratype ♀ in QM; 2 paratype workers each in AMNH, ANIC, BMNH, CASC, JCUT, MCZC, MHNG, MLAC and NMNH. OTHER MATERIAL: QUEENSLAND, Julatten, 16°37'S, 145°20'E, 2.v.1990 (BBL) (w); Black Mtn Rd, 4km N of Kuranda, 16°47'S, 145°37'E, 21.vii.1980, rf. (RJK acc. 80.103, 107, 109) (w); Kuranda, e. 100ft, 4.vi.1962, rf. (RWT acc. 1322) (w); Coperlode Dam Rd, 16°58'S, 145°42'E, 17.x.1991-23.vii.1992, pitfall traps NQ42 (Lawless, Raven, Shaw) (w); Westgid Ck, Bellenden Ker Ra., 1.xi.1981 (GBM & Earthwatch Exp.) (w); Palmerston NP, 17°37'S, 145°48'E, 350-400m, 2.i.1990, rf. (GBM et al.) (w); Upper Boulder Ck, e. 8km N of Tully, 100-500m, 4.xii.1989 (GBM, Thompson, Janetski) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 4.84, 4.68-5.49; HL 1.31, 1.25-1.34; HW 1.22, 1.15-1.28; CI 93, 90-98; SL 1.56, 1.53-1.65; SI 128, 124-133; PW 0.94, 0.94-1.00; MTL 1.78, 1.72-1.87 (20 measured).

Clypeus in profile weakly convex; basal margin moderately impressed. Frontal triangle indistinct. Frontal carinae sinuate, margins weakly raised; central area with short furrow. Sides of head in front of eyes very weakly convex, almost straight, strongly converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes convex, in full face view breaking lateral cephalic outline. Ocelli lacking, relative positions indicated in some specimens by minute depressions in cephalic sculpturation. Pronotum in dorsal view with humeri narrowly rounded, or bluntly angular in some specimens, with greatest width of segment just behind shoulders. Mesosoma in profile more-or-less evenly convex. Promesonotal suture distinct, metanotal groove feebly indicated laterally, indistinct dorsally. Propodeal spines very short, upturned. Petiole in lateral view with anterior face almost straight, posterior face convex; dorsum armed with four spines; dorsal pair triangular, tooth-like, closer to each other than to lateral teeth; lateral pair more acute and slightly longer; subpetiolar process in lateral view acute anteriorly, narrowly rounded posteriorly. Anterior face of first gastral segment relatively low, widely rounding onto dorsum of segment.

Mandibles finely, longitudinally striate-rugose. Dorsum of head, mesosoma, petiole and gaster very finely shagreened, rather polished, with scattered minute punctures and piliferous pits. Sculptural intensity increasing laterally and becoming rather strongly reticulate-rugose, notably on meso- and metapleurae and lower parts of petiole.

Several curved hairs along mandibular masticatory borders with hairs reducing in length towards bases. Anterior clypeal margin with only 1 or 2, relatively long, anteriorly directed setae medially and a few shorter setae fringing margin laterally. A few pairs of medium length, mostly erect hairs near anterior and basal clypeal margins and along frontal carinae; single pair of hairs on vertex and summit of mesosoma. Gaster with a few erect hairs along posterior margins of segments, notably towards apex and on venter. Head, mesosoma, petiole and gaster with very short, appressed pubescence arising from numerous pits and shallow punctures.

Colour: Body black. Mandibular masticatory borders reddish-brown. Antennae very dark brown, condylae and distal ends of scapes a shade lighter. Legs distinctly yellow, orange or reddish-brown, with coxae and proximal ends of tibiae a shade darker; tarsi very dark brown.

Queen. Dimensions: TL c. 7.21; HL 1.72; HW 1.56; CI 91; SL 1.93; SI 124; PW 1.62; MTL 2.40 (1 measured). Apart from sexual characters and distinctly larger size, closely resembling worker except: pronotal humeri rounded; mesoscutum only marginally wider than long with lateral margins rather strongly converging anteriorly, forming distinctly narrowly rounded anterior margin. Median line relatively short; parapsides rather flat, slightly raised posteriorly; mesoscutum in profile weakly convex anteriorly, virtually flat posteriorly. Mesoscutellum convex in lateral view, well elevated above dorsal plane of mesosoma; metanotal groove distinct. Propodeum armed with distinct, somewhat dorsoventrally compressed, weakly upturned spines; dorsum descending rather abruptly into virtually vertical declivity; petiolar spines marginally longer. Sculpturation, pilosity and colour as in worker.

Males unknown. Immature stages (eggs, larvae and pupae) deposited in the QM spirit collection.

REMARKS. *Polyrhachis abbreviata* is a relatively rare species apparently restricted to Queensland's Wet Tropics. Like other *Cyrtomyrma* species, it builds nests of larval silk and vegetation debris between the leaves of rainforest trees and shrubs. *Polyrhachis abbreviata* is rather similar to *P. yorkana* (Fig. 4G-H) with which it is sympatric at Mission Beach. They differ notably in their size (HL 1.25-1.34 in *P. abbreviata* versus 1.53-1.62 in *P. yorkana*) and in the colour of their appendages which, in *P. abbreviata*, are yellow, orange or light reddish-brown. In contrast the legs in *P. yorkana* are brown to dark reddish-brown. Also, the petiole in profile is distinctly lower and wider in *P. abbreviata* compared to *P. yorkana*. This species was listed as *Polyrhachis* '*Cyrto* 08' by Kohout (2000: 197).

Polyrhachis australis Mayr, 1870
(Fig. 4A-B)

Polyrhachis australis Mayr, 1870: 945. Holotype worker. Type locality: Port Mackay, Ostaustralien (= Mackay, QUEENSLAND) (type presumed lost). Neotype worker (here designated): Cape Hillsborough NP, 20°55'S, 149°02'E, 1.vi.1996 (RJK acc. 96.2) in QM (QMT99332).

Polyrhachis levior Roger, 1863: 8; Mayr, 1876: 71 (spurious synonymy of *P. australis* under *P. levior*).

Polyrhachis (Cyrtomyrma) nox Donisthorpe, 1938: 249, fig. 2. Synonymy by Kohout & Taylor, 1990: 513.

Polyrhachis (Cyrtomyrma) townsvillei Donisthorpe, 1938: 251, fig. 4. Synonymy with *P. doddi* Donisthorpe by Kohout, 1998: 527.

Polyrhachis (Cyrtomyrma) doddi Donisthorpe, 1938: 263, fig. 13. Synonymy by Kohout, 2000: 195.

Polyrhachis (Cyrtomyrma) australis Mayr. Kohout, 2000: 195, figs 2C, 4C.

REMARKS. Kohout & Taylor (1990) reported the absence of the holotype of *P. australis* from the Mayr collection (NHMW) and subsequent enquiries to the Hamburg Museum (ZIZM) support their opinion that it has been destroyed. However, when Mayr (1876) incorrectly synonymised *P. australis* with *P. levior*, he also listed 'Rockhampton' and 'Peak Downs' as localities additional to 'Port Mackay', from which specimens were sent to him by the Godeffroy Museum. Considering that Mayr regarded all these specimens as conspecific, the identity of *P. australis* can be established with confidence. I have examined eight available specimens of that series lodged in the Mayr collection and identified by Mayr between 1874-1876 as *P. levior* Roger. All bear identification tags in Mayr's handwriting reading '*P. laevior* (sic) R. det. G. Mayr' and locality labels variously inscribed 'Godeffr., Australia, 1876', 'Rockhampt., Godeffr., 1874' or 'Godeffr., Rockhampt., 1876'. Following its erroneous synonymy with *P. levior* (Mayr, 1876), *P. australis* became one of the most misunderstood Australian species of the subgenus and specimens from Queensland with more-or-less angular humeri and propodeal spines were commonly identified as *P. levior*. Donisthorpe (1932) was the first author who examined the unique holotype worker of *P. levior* in the W.W. Saunders collection in Oxford (OXUM) and realised that specimens from Queensland, supplied by F.P. Dodd and R.E. Turner, were not conspecific. Consequently, Donisthorpe (1938) described three new species from that material; *P. doddi, P. nox* and *P. townsvillei* which are all now considered synonyms of *P. australis*.

In order to establish the nomenclatural stability of the species, I hereby designate, in accordance with Article 75 of the International Code of Zoological Nomenclature (Fourth Edition), a worker specimen as the neotype of *Polyrhachis australis* Mayr. The specimen was directly compared and considered conspecific with the specimens from Queensland identified by Mayr as *P. levior* (see above) and with the syntypes of *P. doddi* and *P. nox*. The specimen was selected from a polydomous colony collected from a silk nest built between the leaves of low shrub in open forest at Cape Hillsborough NP (RJK acc. 96.2). This locality is situated only about 30km NW of Mackay, the type locality of *P. australis*. The neotype has been deposited in the QM, together with the rest of the colony consisting of 106 workers, 4 alate queens and numerous immature stages (eggs, larvae in various stages of development and pupae).

Polyrhachis australis is a characteristic species combining more-or-less angular pronotal humeri with well developed propodeal spines. It closely resembles *P. hoelldobleri* described below, but differs in the development of pronotal humeri. In *P. australis* the humeri are obtusely angular or narrowly rounded (Fig. 4B), while all examined specimens of *hoelldobleri* have distinctly angular or virtually bilobed humeri (Fig. 2I), similar to those of *P. levior* Roger from Indonesia or *P. pacifica* sp. nov. from the Solomons. In addition, the lateral petiolar spines in *P. australis* are distinctly longer than the dorsal spines, while all the petiolar spines in *P. hoelldobleri* are subequal. *Polyrhachis australis* is a rather common species in suitable localities along the tropical and subtropical coast of eastern Australia, ranging from about Cairns south to the Queensland-New South Wales border and as far west as Forty Mile Scrub and Undara. A single speciment has very recently been collected from Davenport Range NP in the Northern Territory (A. Andersen, pers. comm.). It is an arboreal species that builds nests of silk and vegetation debris between the leaves of trees and shrubs along the margins of lowland rainforests and woodlands.

Polyrhachis brevinoda sp. nov.
(Fig. 1B, F-G)

MATERIAL. HOLOTYPE: QUEENSLAND, Kirrama Ra, e. 9km W of Kennedy, 18°12'S, 145°42'E, e. 110m, 4.vi.1996, rainforest, ex nest between leaves, R.J. Kohout acc. 96.14 (worker). PARATYPES: data (and nest) as for holotype (59 workers); Mission Beach, e. 4km WbyS of, 17°53'S, 146°04'E, 29.ii.1996, lowland rf., ex nest between leaves, S.K.A. Robson #256 (13 workers, 1 dealate ♀). Type deposition: Holotype (QMT99333), most paratypes from holotype nest, 7 paratypes and 1 paratype ♀ in QM; 4 paratypes (2 from holotype nest) each in ANIC, BMNH and MCZC; 2 paratypes (from holotype nest) each in AMNH, CASC, JCUT, MHNG, MLAC and NMNH. OTHER MATERIAL: PAPUA NEW GUINEA, Central Prov., nr Eilogo, 21.xii.1980 (J.W. Ismay) (w). WESTERN AUSTRALIA: West Kimberley, Windjana Gorge NP, 8.vii.2001 (P. Filewood #07) (single w). QUEENSLAND, Cape York Pen., 12km W of Captain Billy, 11°38'S, 142°44'E, 7.xii.1992, rf. (P. Zborowski & K. Halfpapp) (w); Iron Ra., 12°42'S, 143°18'E, 9-15.vi.1971, rf. (RWT & J. Feehan acc. 71.163) (w); ditto, 1-3.vii.1976, rf. (P. Filewood) (w); ditto, Gordon Ck x-ing, 14-16.i.1992, rf. (RJK acc. 92.2, 4) (w, ♀); ditto, 1-6.x.2000, rf. (RJK acc. 2000.128) (w); 9km ENE of Mt Tozer, 12°43'S, 143°17'E, 5-10.vii.1986 (T. Weir & A. Calder) (w);

11km ENE of Mt Tozer, 12°43'S, 143°18'E, 11-16.vii.1986 (T. Weir & A. Calder) (♀); West Claudie R., 12°44'S, 143°14'E, c. 50m, 3-10.xii.1985, rf. (GBM & DJC) (w); Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996, rf. edge (CJB & RJK acc. 96.43) (w); Parrot Ck upper, 15°48'S, 145°16'E, 300m, 22.xi.1998, rf. (GBM, P. Bouchard & A. O'Toole #1933) (w); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°28'E, 1.i.1991 (R. Kitching) (w); Cape Tribulation, Canopy Crane Site, 16°06'S, 145°27'E, 9.v.1997 (SKR #550) (w); ditto, 9-10.ix.2001, lowland rf. (RJK acc. 2001.29, 32) (w, ♀); Noah Ck, S of Cape Tribulation, 16°08'S, 145°25'E, 13-19.x.1980 (GBM) (w); ditto, 25-28.vii.1993, rf., pyreth. (H. Mitchell) (w, ♀); Oliver Ck, 8km SWbyS of Cape Tribulation, 16°08'S, 145°26'E, 14.vi.1996, rf. (RJK acc. 96.53) (w); McLean Ck, e. 19km SbyW of Cape Tribulation, 16°15'S, 145°26'E, 15.vi.1996, rf. (RJK acc. 96.54) (w); Black Mtn Rd, Kuranda, 3.vi.1962, rf. (RWT acc. 1313) (w); Smithfield, 12km NW of Cairns, e. 1200ft, 16°50'S, 145°41'E, 5.v.1997, second. rf. (SKR #553) (w); Bellenden Ker, Cableway Base stn, 17-24.x.1981 (GBM & Earthwatch Exp.) (w); ditto, 8-23.iv.1987 (E.C. Dahms & G. Sarnes) (w); Garradunga, Seymour Ra., c. 7km N of Innisfail, 17°28'S, 146°01'E, <100m, 5-6.vi.1996, lowland rf. (RJK & CJB acc. 96.31) (w); Mission Beach, 17°52'S, 146°05'E, 29.ii.1996 (SKR #256) (w, ♀, ♂); ditto, 13.x.2004, lowland rf. (SKR #1018, 1019) (w); Kirama Ra., e. 9km W of Kennedy, 18°12'S, 145°52'E, e. 110m, 4.vi.1996, rf. (RJK et al. accs 96.13, 14) (w); ditto, 31.x.1999, rf. (SKR #807) (w); Hinchinbrook I., Gayundah Ck, 18°21'S, 146°13'E, <100m, 8-18.xi.1984 (GBM) (w); Paluma, Little Crystal Ck, 19°00'S, 146°15'E, 29.ii.1996, primary rf. (SKR #147) (w).

DESCRIPTION. *Worker.* Dimensions (holotype cited first): TL c. 5.49, 4.89-6.05; HL 1.40, 1.31-1.53; HW 1.31, 1.18-1.43; CI 93, 87-94; SL 1.81, 1.65-1.93; SI 138, 131-148; PW 1.09, 0.97-1.15; MTL 2.15, 1.93-2.31 (31 measured).

Clypeus in profile rather flat; basal margin weakly impressed. Frontal triangle indistinct. Frontal carinae sinuate with only moderately raised margins; frontal furrow weakly indicated. Sides of head in front of eyes very weakly convex; behind eyes rounding into convex occipital margin. Eyes convex, in full face view breaking lateral cephalic outline. Ocelli lacking; relative positions indicated in some specimens by minute depressions in cephalic sculpturation. Pronotum in dorsal view with humeri widely rounded; greatest pronotal width at or near mid-length of segment. Mesosoma in profile with pronotum rather steeply rising towards weakly convex summit; promesonotal suture distinct; metanotal groove lacking, slight depression in mesosomal outline indicating its position; propodeal dorsum sloping into oblique declivity in open curve. Petiole in profile with anterior face almost straight, posterior face convex; in dorsal view petiole rather narrow, sides more-or-less parallel; petiolar spines very short, dorsal pair reduced to denticles and lateral pair usually merely angulate; subpetiolar process in lateral view acute anteriorly, angular with weakly concave margin posteriorly. Anterior face of first gastral segment lower than height of petiole, widely rounding onto dorsum of segment.

Mandibles very finely, longitudinally striate. Head, mesosoma and gaster very finely shagreened with sculptural intensity increasing laterally and becoming more reticulate over meso- and metapleurae and lateral portions of petiole. Scattered minute punctures in various densities present over all dorsal surfaces.

Several curved hairs along mandibular masticatory borders, numerous very short, appressed hairs arising from pits towards mandibular bases. Anterior clypeal margin usually with 2 long, anteriorly directed setae medially and several short setae along margin laterally. Semierect to erect, mostly paired hairs near anterior and basal clypeal margins and along frontal carinae, a pair of somewhat longer hairs on vertex. Single pair of long, but shorter than greatest diameter of eye, undulated hairs on summit of mesosoma. Medium length, semierect hairs lining posterior margins of gastral segments, their density increasing on venter of gaster. Very short, appressed hairs, arising from minute punctures and pits, distributed over most dorsal body surfaces.

Colour. Head, mesosoma, coxae, petiole and gaster mostly black. Antennae very dark reddish-brown with apical ends a shade lighter. Mandibular masticatory borders and legs medium reddish-brown with tarsi and proximal ends of tibiae darker.

Queen. Dimensions: TL c. 6.75; HL 1.61; HW 1.40; CI 87; SL 2.00; SI 143; PW 1.53; MTL 2.50 (1 measured). Apart from sexual characters, closely resembling worker except: pronotal humeri narrowly rounded; mesoscutum marginally wider than long with lateral margins distinctly converging anteriorly, forming narrowly rounded anterior margin; median line relatively short, bifurcate and slightly raised; parapsides weakly raised posteriorly; mesoscutum in profile with widely rounded anterior face and rather flat dorsum. Mesoscutellum very weakly convex, only marginally elevated above dorsal plane of mesosoma; metanotal groove distinct. Propodeal dorsum armed with distinct denticles; declivity

short and steep. Sculpturation, pilosity and colour virtually identical to worker.

Males and immature stages (eggs, larvae and pupae) deposited in the QM spirit collection.

REMARKS. *Polyrhachis brevinoda* is not an uncommon species within its main distribution which is centered on the Wet Tropics region of north Queensland, extending to Cape York Peninsula and apparently to the southern parts of Papua New Guinea. A single specimen has also been collected in the West Kimberly District of north-western Australia. *Polyrhachis brevinoda* is a rainforest species that builds silk nests between leaves in the lower arboreal zone. It is similar to *P. semiinermis* (Fig. 11C-D), described by Donisthorpe (1941: 209) from the Philippines and *P. damun* sp. nov. (Fig. 6E-F) from Sabah, Borneo. All three species have widely rounded pronotal shoulders and virtually parallel-sided petioles with greatly reduced or rudimentary spines. *Polyrhachis brevinoda* differs in having the propodeal declivity descending in an oblique curve while in *P. semiinermis* and *P. damun* the declivity is virtually vertical. Although the petiolar spines in *P. brevinoda* are short, the dorsal spines are relatively well defined, while the dorsal spines are more-or-less obsolete in the other two species. *Polyrhachis brevinoda* is also distinctly smaller than *P. damun* (HL 1.31-1.53 versus 1.65-1.87 respectively) and has dark brown to black legs (always distinctly red in *P. damun*). *Polyrhachis brevinoda* was listed as *P.* '*Cyrto* 06' by Kohout (2000: 197).

Polyrhachis decumbens sp. nov.
(Fig. 1C, H-I)

MATERIAL. HOLOTYPE: QUEENSLAND, Cape York Pen., Lockerbie Scrub, 10°46'S, 142°29'E, 19-23.iii.1987, ex nest between leaves, R.J. Kohout acc. 87.67 (worker). PARATYPES: data (and nest) as for holotype (15 workers, 1 dealate ♀); data as for holotype, except RJK acc. 87.66 (4 workers). Type deposition: Holotype (QMT99334), 3 paratype workers and paratype ♀ (from holotype nest) and 2 paratype workers in QM; 4 paratype workers (2 from holotype nest) in ANIC; 2 paratype workers (from holotype nest) each in BMNH, MCZC, MHNG and NMNH. OTHER MATERIAL: PAPUA NEW GUINEA, Central Prov., Laloki R., c. 20km N of Port Moresby, 09°15'S, 147°05'E, 9.ii.1979, on citrus (E. Brough #C-234, 235) (w); ditto, Bisianumu, c. 30km NE of Port Moresby, 09°24'S, 147°24'E, 500m, 7.vi.1965, secondary rf. (J.L. Gressitt) (w). QUEENSLAND, Cape York Pen., Lockerbie Scrub, 10°46'S, 142°29'E, 19-23.iii.1987, rf. (RJK acc. 87.20, 66) (w, ♀); ditto, 23-26.ix.2003, rf. (RJK acc, 2003.14, 16) (w); 15km NE by E of Heathlands, 11°41'S, 142°42'E, 15-26.i.1992 (I. Naumann & T. Weir) (w); 14km ENE of Heathlands, 11°41'S, 142°42'E, 26.ii.1993 (P. Zborowski) (w); Heathlands, 11°45'S, 142°35'E, 18-20 viii 1992 (P. Zborowski & J. Cardale) (w); Iron Ra., 12°42'S, 143°18'E, 9-15.vi.1971 (RWT & J. Feehan acc 135, 138, 141, 148) (w); ditto, 1-3.vii.1976 (P. Filewood) (w); ditto, 17.iii.1984 (J.H. Sedláček) (w); ditto, Gordon Ck x-ing, 1-6.x.2000 (RJK acc. 2000.130) (w); East Claudie R., Iron Ra., 12°42'S, 143°17'E, 6.xii.1985, pyrethrum (GBM & DJC) (w); 9km ENE of Mt Tozer, 12°43'S, 143°17'E, 5-10.vii.1986. pantraps (J.C. Cardale) (w); 11km ENE of Mt Tozer, 12°43'S, 143°18'E, 11-16.vii.1986 (T. Weir & A. Calder) (w); West Claudie R., 12°44'S, 143°14'E, c. 50m, 3-10.xii.1985, pyrethrum (GBM & DJC) (w).

DESCRIPTION. *Worker*: Dimensions (holotype cited first): TL c. 5.14, 4.79-5.49; HL 1.34, 1.22-1.40; HW 1.31, 1.17-1.40; CI 98, 93-100; SL 1.65, 1.50-1.78; SI 126, 121-130; PW 1.00, 0.87-1.03; MTL 1.65, 1.65-1.93 (23 measured).

Clypeus in profile straight; basal margin moderately impressed. Frontal triangle indistinct. Frontal carinae sinuate, margins very weakly raised anteriorly, rather flat posteriorly. Sides of head in front of eyes weakly convex; rounding behind eyes into convex occipital margin. Eyes convex, in full face view clearly breaking lateral cephalic outline. Ocelli lacking. Pronotum in dorsal view with humeri widely rounded; greatest pronotal width at or near mid-length of segment. Mesosomal dorsum in profile evenly convex; promesonotal suture distinct, metanotal groove lacking. Petiole with anterior face almost straight, posterior face weakly convex; dorsum armed with four subequal, acute spines. Subpetiolar process acute anteriorly, rounded posteriorly. Anterior face of first gastral segment straight, relatively low, narrowly rounding onto dorsum of segment.

Head, mesosoma and gaster shagreened, with intensity of sculpturation markedly increasing laterally, becoming distinctly wrinkled; sculpturation strongly reticulate-rugose on meso- and metapleurae and sides of petiole.

Several curved and subcrect hairs on mandibular masticatory borders with shorter appressed hairs towards mandibular bases. Anterior clypeal margin with 1 long and 2 slightly shorter, anteriorly directed setae medially and several short setae fringing margin laterally. Mostly paired, medium length, erect hairs near anterior and basal margins of clypeus, along frontal carinae and on vertex; tuft of usually 4 erect, undulated, medium length hairs on summit of mesosoma. Gaster with numerous semierect hairs lining posterior margins

of apical segments, more numerous on venter. Pubescence consisting of abundant very fine, short, decumbent and semierect hairs everywhere, including appendages, but excluding propodeal declivity that is smooth and shiny.

Colour. Black with mandibles, clypeus, sides of head and tibiae medium to dark reddish-brown, except mandibular masticatory borders and legs, including coxae, distinctly lighter. Dorsum of gaster black, posterior margins of segments diffusely lined with dark reddish-brown.

Queen. Dimensions (queen from nest of holotype cited first): TL c. 7.00, 7.26; HL 1.62, 1.72; HW 1.43, 1.59; CI 88, 92; SL 1.96, 2.06; SI 137, 129; PW 1.56, 1.68; MTL 2.46, 2.59 (2 measured). Apart from sexual characters, closely resembling worker except: pronotal humeri rounded; mesoscutum marginally wider than long with lateral margins converging anteriorly, forming relatively narrowly rounded anterior margin; median line bifurcate and weakly raised; parapsides flat anteriorly, slightly raised posteriorly; mesoscutum in profile with widely rounded anterior face and very weakly convex dorsum. Mesoscutellum only weakly convex, marginally elevated above dorsal plane of mesosoma. Metanotal groove distinct. Propodeum armed with distinct denticles; dorsum descending abruptly into virtually vertical declivity. Sculpturation, pilosity and colour virtually as in worker.

Male unknown. Immature stages (eggs, larvae and pupae) deposited in the QM spirit collection.

REMARKS. The distribution of *P. decumbens* appears to be centered on Cape York Peninsula, north of the 13° parallel, extending to southern Papua New Guinea. It is a rather common species at suitable rainforest localities where it builds arboreal nests of silk and vegetation debris between the leaves of trees and shrubs. *Polyrhachis decumbens* is similar to *P. nomo* (Fig. 10G-H) from New Guinea. Both share the characteristic pile of short, decumbent hairs covering most of the body. However, the pubescence in *P. decumbens* is abundant, while it is rather diluted in *P. nomo*. They differ in other aspects, including their relative size (HL 1.22-1.40 in *P. decumbens* versus 1.47-1.50 in *P. nomo*), and in the shape of their heads. In *P. nomo* the head is wider than long (CI 104-106) with the eyes not reaching the lateral cephalic outline in full face view. In *P. decumbens* the head is mostly longer than wide (CI 93-100) and the eyes clearly break the lateral cephalic outline. Both species feature rounded lateral pronotal margins, but several *P. decumbens* specimens from Iron Range have weakly indicated, blunt humeral angles and the pronotal dorsum is distinctly widest across the shoulders. Some of these specimens also feature more-or-less distinct, rudimentary propodeal spines or tubercles, that are completely absent in specimens of other populations of *P. decumbens* and in *P. nomo*. The spines of the petiole in *P. decumbens* are subequal, while in *P. nomo* the lateral petiolar spines are distinctly longer.

Polyrhachis delecta sp. nov.
(Fig. 2A, D-E)

MATERIAL. HOLOTYPE: QUEENSLAND, Palmerston NP, 17°37'S, 145°48'E, c. 400m, 4.v.1997, primary rf, S.K.A. Robson aec. #551 (worker). PARATYPES: data (and nest) as for holotype (294 workers, 1 dealate ♀, 67 alate ♀♀, 77 ♂♂). Type deposition: Holotype (QMT99335), paratype dealate ♀, most paratype workers, alate ♀♀ and ♂♂ in QM; 3 paratype workers and 1 paratype alate ♀ each in ANIC, BMNH and MCZC; 2 paratype workers each in AMNH, CASC, JCUT, MHNG, MLAC and NMNH. OTHER MATERIAL: QUEENSLAND, Helenvale, 15°42'S, 145°13'E, 10-20.vii.1976 (P. Filewood) (w); Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996, rf. edge (RJK & CJB acc. 96.43) (w); ditto, x-xi.1974 (T.P. Tebble) (w); Mt Hartley, 15°46'S, 145°19'E, 500-700m, 11.v.1996, rf. (CJB) (w); Shiptons Flat, 15°47'S, 145°13'E, 240m, 5.xii.1990 (GBM et al.) (w); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°28'E, 1.ii.1991, fogging (R. Kitching) (w); Cape Tribulation, Canopy Crane site, 16°06'S, 145°27'E, 9-10.ix.2001, lowland rf. (RJK accs 2001.17, 19) (w, ♀); ditto, ix.1999- iii.2002 (N. Blüthgen) (w); ditto, 9.ix.2001 (S. Yamane #33) (w); Mt Hemmant, 6km SW of Cape Tribulation, 16°07'S, 145°25'E, 25.iv.1983 (GBM & DJC) (w); Noah Ck, S of Cape Tribulation, 16°08'S, 145°25'E, 25-28.vii.1993, pyreth. (H. Mitchell) (w); Rumula, Kingfisher Pk, 16°35'S, 145°20'E, 13.x.2004, e. 400m (S. Townsend) (w, ♀); Kuranda, 16°49'S, 145°38'E, 10-20.vii.1976 (P. Filewood) (w); Cairns, Botanic Gardens, 16°54'S, 145°45'E, 19.x.1996 (SKR #647) (w); Crystal Cascades nr Cairns, 16°57'S, 145°40'E, 2.iii.1996, primary rf. (SKR #214) (w); Bell Peak Nth, 20km S of Cairns, 17°05'S, 145°53'E, 16.ix.1981 (GBM & DJC) (w); Goldsborough Valley SF, e. 10km SW of Gordonvale, 17°09'S, 145°42'E, 18.x.1995 (SKR #54) (w); ditto, 29.ii.1996, prim. rf. (SKR #219, 223) (w, ♀); Atherton Tbld, Yungaburra, Paterson Ck, 17°16'S, 145°34'E, c. 700m, 29.ix.2003 (RJK aec. 2003.29) (w); ditto, 19.vii.2004 (SKR #1007.1008) (w); Bellenden Ker, Cableway Base Stn, 17-24.x.1981 (GBM & Earthwatch Exp.) (w); ditto, 8-23.iv.1987 (E. Dahms & G. Sarnes) (w); The Boulders, 6km W of Babinda, 17°20'S, 145°52'E, 18.v.1990, rf. (BBL) (w); Babinda, 17°21'S, 145°56'E, 4.viii.1985,

rf. edge (BBL) (w); Stone Ck, Seymour Ra., 17°27'S, 146°01'E, 22.viii.1995 (P. Hasenpush) (w); Etty Bay, 7km ESE of Innisfail, 17°33'S, 146°05'E, 23.vii.1980 (RJK acc. 80.156) (w); NE of Tully, nr Bingli Bay, 30.iv.1969 (RWT acc. 69.135) (w); Mission Beach – El Arish Rd, 17°52'S, 146°04'E, 4.xii.1995, lowland rf. (SKR # 802) (w); Tam O'Shanter FP, c. 4km WbyS of Mission Bch, 17°53'S, 146°04'E, 29.ii.1996, lowland rf. with *Licuala* palms (SKR #260) (w, ♀); ditto, 19.x.1996 (SKR #645, 648) (w, ♂); ditto, 7.ix.2001 (RJK acc. 2001.13) (w); ditto, 8.ix.2001 (S. Yamane #17) (w); 6km W of Sth Mission Beach, 17°56'S, 146°02'E, 18-19.vii.1980, lowland rf. (RJK acc. 80.66) (w); Kirrama Ra., c. 9km W of Kennedy, 18°12'S, 145°52'E, primary rf., 7.ix.2001 (S. Yamane) (w, ♂); Palm I., 18°45'S, 146°36'E, 450m, 20-21.ii.2001, rf. (G.B. Monteith #8323, 8332) (w); Mt Elliot NP, North Ck, 500-800m, 2.xii.1986 (GBM et al.) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.35, 5.90-6.50; HL 1.62, 1.47-1.62; HW 1.59, 1.40-1.59; CI 98, 93-100; SL 1.90, 1.81-1.96; SI 119, 119-129; PW 1.25, 1.15-1.28; MTL 2.31, 2.09-2.37 (25 measured).

Clypeus in profile rounding into shallowly impressed basal margin in weakly convex line. Frontal triangle rather indistinct. Frontal carinae sinuate with moderately raised margins; central area with moderately impressed frontal furrow. Sides of head in front of eyes very weakly convex; behind eyes rounding into convex occipital margin. Eyes moderately convex, in full face view just breaking lateral cephalic outline. Ocelli lacking. Pronotal humeri in dorsal view widely rounded; greatest width of pronotum at mid-length of segment. Mesosoma in profile evenly convex; promesosonal suture distinct; metanotal groove lacking, position indicated by slight depression in mesosomal outline; propodeal dorsum narrowly rounding into rather steep declivity. Petiole with anterior face almost straight, posterior face convex; dorsal margin armed with four acute, subequal spines. Subpetiolar process angular anteriorly, blunt posteriorly. Anterior face of first gastral segment relatively low, widely rounding onto dorsum of segment.

Mandibles very finely, longitudinally rugose. Dorsum of head, mesosoma and gaster finely shagreened with intensity of sculpturation increasing laterally, sides of mesosoma and petiole strongly reticulate-rugose. All dorsal body surfaces, including mandibles, with numerous minute punctures and piliferous pits.

Several curved and semierect hairs arising from mandibular masticatory borders. Anterior clypeal margin usually with 3 longer, anteriorly directed setae and fringe of shorter setae lining margin laterally. Several paired, medium length, hairs near anterior and basal clypeal margins and along frontal carinae; a pair of somewhat longer hairs on vertex. Tuft of a few, weakly curved hairs, shorter than greatest diameter of eye, on summit of mesonotum. Medium length hairs lining posterior margins of gastral segments, more numerous on venter.

Colour: Black, including antennae, coxae and tarsi. Mandibular masticatory borders, extreme tip of apical funicular segments, condylae and posterior margins of gastral segments reddish-brown. Femora and tibiae light to medium reddish-brown, except proximal ends of tibiae distinctly darker.

Queen. Dimensions: TL c. 7.26-8.06; HL 1.72-1.78; HW 1.65-1.68; CI 93-98; SL 2.03-2.09; SI 121-127; PW 1.81-1.93; MTL 2.56-2.71 (6 measured). Apart from sexual characters, similar to worker except: eyes larger, in full face view clearly breaking cephalic outline. Pronotal humeri narrowly rounded; mesoscutum marginally wider than long; lateral margins converging anteriorly, forming relatively widely rounded anterior margin; median line bifurcated posteriorly; parapsides weakly indicated, slightly raised posteriorly; mesoscutum in profile with relatively high, widely rounded anterior face and flat dorsum. Mesoscutellum in profile convex, weakly elevated above dorsal plane of mesosoma; metanotal groove distinct. Propodeal dorsum descending into virtually vertical declivity. Petiole with spines shorter and blunter. Sculpturation and colour pattern essentially as in worker.

Males and immature stages (eggs, larvae and pupae) deposited in the QM spirit collection.

REMARKS. *Polyrhachis delecta* is a rather common species, endemic to the rainforests of Queensland's Wet Tropics. Its nesting habits are like those of other *Cyrtomyrma* species that build their nests between the leaves of trees and shrubs. *Polyrhachis delecta* is remarkably similar to *P. euryala* Fr. Smith from Indonesia (discussed below under the New Guinean species). Both are distinctly slender with a relatively narrow mesosoma and widely rounded pronotal shoulders. However, *P. delecta* has distinctly shorter antennal scapes (SI 119-129 versus 140-147 in *P. euryala*) and subequal petiolar spines. In *P. euryala* the lateral petiolar spines are distinctly longer than the dorsal pair.

Polyrhachis expressa sp. nov.
(Fig. 2B, F-G)

MATERIAL. HOLOTYPE: QUEENSLAND, Cape York Pen., Iron Ra. NP, nr Gordon Ck x-ing, 12°42'S, 143°18'E, 1-6.x.2000, R.J. Kohout acc. 2000.177 (worker). PARATYPES: data as for holotype (269 workers). Type deposition: Holotype (QMT99336) and most paratypes in QM; 4 paratypes each in ANIC, BMNH and MCZC; 2 paratypes each in AMNH CASC, JCUT, MHNG, MLAC and NMNH. OTHER MATERIAL: QUEENSLAND, Cape York Pen., Iron Ra. NP, 12°42'S, 143°18'E, 9-15.vi.1971, rf. (RWT & J. Feehan acc. 71.148) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 5.64, 5.49-6.15; HL 1.47, 1.43-1.56; HW 1.47, 1.42-1.56; CI 100, 99-103; SL 1.78, 1.72-1.84; SI 121, 116-122; PW 1.12, 1.06-1.18; MTL 2.18, 2.12-2.31 (16 measured).

Clypeus in profile straight anteriorly, rounding posteriorly into moderately impressed basal margin. Head about as wide as long; sides of head in front of eyes weakly convex; behind eyes sides converging into convex occipital margin. Eyes only moderately convex, in full face view just breaking lateral cephalic outline. Ocelli lacking. Pronotal humeri widely rounded in dorsal view. Mesosoma in profile with pronotal dorsum strongly convex, rising steeply towards short summit and descending towards distinct promesonotal suture; mesonotum weakly convex, metanotal groove indistinct, indicated only by depression in lateral outline; propodeal dorsum rather flat, armed with a pair of relatively long, slender, bluntly terminated spines. Petiole with anterior face almost straight, posterior face moderately convex; dorsal margin armed with four spines, dorsal pair broad-based and tooth-like, lateral pair widely diverging, slender, more than twice as long as dorsal pair. Subpetiolar process acute anteriorly, narrowly rounded posteriorly. Anterior face of first gastral segment flat, narrowly rounding onto dorsum of segment.

Head and gaster finely shagreened with dense cover of minute punctures and piliferous pits. Mesosoma and petiole more strongly sculptured with intensity of sculpturation distinctly increasing laterally; lower portions of pronotum, meso- and metapleurae and petiole, strongly reticulate-rugose.

Several curved or semierect hairs on masticatory borders, with distinctly shorter, mostly appressed hairs towards mandibular bases. Anterior clypeal margin medially with several rather long, anteriorly directed setae and with fringe of shorter setae lining margin laterally. A few medium length hairs along ventral margins of gastral segments. Very short, appressed hairs, arising from minute punctures and pits, rather densely distributed over all dorsal body surfaces.

Dorsum of head, antennal scapes, mesosoma, petiole, first gastral segment and tarsi black. Mandibles, condylae, antennal scapes distally, narrow bands on funicular segments, and legs, including coxae, medium to dark reddish-brown. Extreme tip of apical funicular segment distinctly lighter. Clypeus, sides of head and posterior margins of gastral segments somewhat diffusely reddish-brown.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis expressa* is known only from the type locality at Iron Range and all of the 270 specimens of the type series were collected foraging on stems of *Bamboosa forbesi* within a small area of monsoonal rainforest. Their nesting habit is unknown, but it is very probable that they use hollow bamboo internodes. *Polyrhachis expressa* is very similar to *P. emeryana* Mann (Fig. 12A-B) from the Solomons. Both species have widely rounded pronotal shoulders, a propodeum armed with spines and distinctly elongated lateral petiolar spines. However, *P. expressa* differs by its finer sculpturation, notably on the dorsum of the head and mesosoma, and its less convex pronotal dorsum. The propodeal spines in *P. expressa* are quite long, columnar and bluntly terminated, while in *P. emeryana* they are short, triangular and acute. Also, the appressed pubescence in *P. expressa* is extremely short and inconspicuous, while it is distinctly longer and more prominent in *P. emeryana*.

Polyrhachis hoelldobleri sp. nov.
(Fig. 2C, H-I)

MATERIAL. HOLOTYPE: QUEENSLAND, Kirrama Ra., c. 9km W of Kennedy, 18°12'S, 145°52'E, 110m, 4.vi.1996, primary rf., R.J. Kohout et al. acc. 96.13 (worker). PARATYPES: data as for holotype (7 workers); Kuranda, 16°49'S, 145°39'E, 5.vii.1980, B. Hölldobler #109 (2 workers); The Boulders, c. 6km W of Babinda, 17°21'S, 145°52'E, 3.ii.1958, Darlingtons (1 worker); East Palmerston, 1.6km E, 17°35'S, 145°50'E, c. 200m, 6.xi.1966, rf., R.W. Taylor accs 66.283, 286 (2 workers, 1 ♀). Type deposition: Holotype (QMT99337) and 2 paratypes in QM; 2 paratype workers, 1 paratype ♀ in ANIC, 2 paratype workers in BMNH and MCZC; 1 paratype worker in IZUW (Hölldobler coll.).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 5.64, 5.24-6.60; HL 1.47, 1.47-1.68; HW 1.50, 1.43-1.65; CI 102, 96-102; SL 1.75, 1.68-2.00; SI 117, 117-121; PW 1.22, 1.18-1.40; MTL 2.03, 2.03-2.40 (9 measured).

Clypeus in profile straight anteriorly, weakly rounging posteriorly into moderately impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate with moderately raised margins; central area weakly convex with short, weakly indicated frontal furrow. Sides of head in front of eyes weakly convex; behind eyes sides rounding into convex occipital margin. Eyes moderately convex, in full face view just reaching cephalic outline. Ocelli lacking; relative positions indicated by shallow punctures in sculpture. Pronotum in dorsal view strongly transverse with humeri distinctly toothed or bilobed. Mesosoma in profile more-or-less evenly convex; promesonotal suture distinct, metanotal groove lacking dorsally, weakly indicated laterally; propodeum armed with pair of relatively long, upturned spines; declivity rather short, steep. Petiole relatively low, anterior face almost straight, posterior face moderately convex; dorsum armed with four spines; lateral pair more slender and slightly longer than dorsal pair. Subpetiolar process angular anteriorly, narrowly rounded posteriorly. Anterior face of first gastral segment relatively low, evenly rounding onto dorsum of segment.

Mandibles very finely, longitudinally rugose with shallow, minute punctures. Head, mesosoma and gaster finely shagreened; intensity of sculpturation moderately increasing across lateral portions of mesosoma with meso- and metapleurae and petiole rather weakly reticulate-rugose.

Several curved and semierect hairs arising from mandibular masticatory borders. Anterior clypeal margin medially with 1 or 2 anteriorly directed longer setae and several shorter setae lining margin laterally. Medium length, erect hairs, mostly in pairs, near anterior and basal clypeal margins, along frontal carinae, on vertex and summit of mesosoma. Only a few hairs lining apical gastral segments with more hairs on gastral venter.

Colour. Mostly black, with extreme tips of apical funicular segments, condylae and mandibular masticatory border narrowly reddish-brown. Antennae, including funiculi, very dark brown to black. Legs, including trochanters, light to medium reddish-brown with distal half of femora and proximal half of tibiae a shade darker; tarsi black.

Queen. Dimensions: TL c. 7.51; HL 1.81; HW 1.78; CI 98; SL 2.03; SI 114; PW 1.72; MTL 2.68 (1 measured). Single dealate queen, apart from sexual characters, very similar to worker mounted on same pin except: eyes more prominent, clearly breaking lateral cephalic outline in full face view. Pronotal humeri produced into blunt, angular prominences; mesoscutum marginally wider than long with lateral margins distinctly converging anteriorly, forming rounded anterior margin; median line weakly indicated, bifurcate posteriorly; parapsides flat, weakly raised posteriorly; mesoscutum in profile with widely rounded anterior margin and flat dorsum. Mesoscutellum in lateral view marginally raised above dorsal plane of mesosoma, weakly convex; metanotal groove distinct. Propodeum armed with pair of distinct, blunt, somewhat dorsoventrally flattened spines; propodeal declivity very steep. Petiole relatively low with lateral spines only moderately elongated; dorsal pair reduced to short, broad-based teeth. Sculpturation, pilosity and colour as in worker.

Male and immature stages unknown.

REMARKS. *Polyrhachis hoelldobleri* has been collected on only a few occasions. Repeated visits to the type locality failed to produce any additional specimens (SKR *pers. comm.*). The type series specimens were swept from low foliage and vegetation (RJK) and hand collected from low foliage (B. Hölldobler) or from the logs and trunks of recently felled trees (RWT). *Polyrhachis hoelldobleri* is evidently restricted to the eastern slopes of the Great Dividing Range within Queensland's Wet Tropics. It is characterised by its strongly transverse pronotal dorsum with the shoulders distinctly angular or bilobed and is similar to *P. pacifica* sp. nov. (Fig. 12C-D) from the Solomons. However, they differ markedly in the outline of the mesosoma. In *P. hoelldobleri* the mesosomal dorsum is more-or-less evenly rounded, while *P. pacifica* features a very prominent, strongly convex pronotal dorsum, similar to that in *P. emeryana* and *P. expressa*. *Polyrhachis hoelldobleri* was listed as *P.* '*Cyrto* 09' by Kohout (2000: 197).

Polyrhachis mackayi Donisthorpe, 1938
(Fig. 4C-D)

Polyrhachis (Cyrtomyrma) mackayi Donisthorpe, 1938: 258, fig. 9; Kohout, 2000: 195. Syntype workers, queen. Type locality: QUEENSLAND, Mackay (R.E. Turner), BMNH (examined).

REMARKS. *Polyrhachis mackayi* is characterised by the evenly convex profile of the mesosomal dorsum (Fig. 4C), rounded pronotal humeri, a completely unarmed propodeum and relatively short and subequal petiolar spines. It ranges from just north of Mackay in Queensland south to Taree in northern New South Wales, where, together with *P. pilosa*, it represents the southern-most limit of the distribution of the subgenus. *Polyrhachis mackayi* is a relatively uncommon species that builds its nests between the leaves of trees and shrubs, mostly along the margins of lowland rainforests and woodlands.

Polyrhachis monteithi sp. nov.
(Fig. 3A, D-E)

MATERIAL. HOLOTYPE: QUEENSLAND, Garradunga, Seymour Ra., c. 7km N of Innisfail, 17°28'S, 146°01'E, <100m, 5-6.vi.1996, lowland rf., R.J. Kohout acc. 96.30 (worker). PARATYPES: data (and nest) as for holotype (12 workers, 7 alate ♀♀, 15♂♂); data as for holotype, except RJK acc. 96.22 (75 workers, 2 dealate, 2 paratype alate ♀♀). Type deposition: Holotype (QMT99338), 6 paratype workers, 4 paratype ♀♀, paratype ♂♂ (from holotype nest) and most paratype workers and paratype ♀♀ in QM; 3 paratype workers, 1 paratype ♀♀ (from holotype nest) and 2 paratype workers each in ANIC, BMNH and MCZC; 2 paratype workers each in AMNH, CASC, JCUT, MHNG, MLAC and NMNH. OTHER MATERIAL: QUEENSLAND, Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996, rf. edge (RJK & CJB accs 96.39, 40, 43) (w, ♀, ♂); Mt Hartley, 15°46'S, 145°19'E, 200-500m, 11.vi.1996, rf. (CJB & RJK acc. 96.45) (w); Pilgrim Sands, 1km NW of Cape Tribulation, 16°04'S, 145°28'E, 12-15.vi.1996 (RJK acc. 96.47) (w); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 20-21.ii.2000 (RJK accs 2000.21, 23, 25, 28, 29, 31, 34, 39) (w); Oliver Ck, 16°08'S, 145°26'E, 14.vi.1996 (RJK acc. 96.53) (w); Mc Lean Ck, c. 19k SbyW of Cape Tribulation, 16°15'S, 145°26'E, 15.vi.1996 (RJK acc. 96.54) (w); O'Donoghues Falls, 16°26'S, 145°20'E, 150m, 15-16.v.1995 (GBM, Ford & Slaney) (w); Julatten, 16°37'S, 145°20'E, 2.v.1990 (BBL) (w); Black Mtn Rd, 4km N of Kuranda, 16°47'S, 145°38'E, 21.vii.1980 (RJK acc. 80.104) (w); Hann Tbld, 16°49'S, 145°11'E, 1000m, 11-13.xii.1995 (DJC) (w); Kennedy Hwy, 4km ESE of Kuranda, 16°50'S, 145°40'E, 12.v.1974 (RJK accs 74.25, 26) (w, ♀, ♂); Yarrabah, c. 11km E of Cairns, 16°56'S, 145°52'E, 22-24.vii.1980 (RJK acc. 80.111) (w); Bellenden Ker, Cableway Base Stn, 8-23.iv.1987 (E. Dahms & G. Sarnes) (w); Russel R., Bellenden Ker Landing, 1-9.xi.19981 (GBM & Earthwatch Exp.) (w); Atherton Tbld, Yungaburra, Paterson Ck, 17°16'S, 145°34'E, c.700m, 29.ix.2003 (RJK accs 2003.31, 32) (w); Atherton Tbld, xii.1983 (J. Sedláček) (w); The Boulders, e. 6km W of Babinda, 17°20'S, 145°52'E, 1990 (W. Travers) (w, ♀, ♂); Josephine Falls, 17°26'S, 145°51'E, 12.ii.1996 (GBM) (w); Seymour Ra., Garradunga, c. 7km N of Innisfail, 17°28'S, 146°01'E, <100m, 7.xi.1996, lowland rf. (JPH) (w); Palmerston NP, 17°37'S, 145°48'E, 350-400m, 2.i.1990, rf. (GBM) (w); Mission Beach-El Arish Rd, 17°52'S, 146°04'E, 4.xii.1995, lowland rf. (SKR #804) (w); c. 6km W of Sth Mission Beach, 17°56'S, 146°02'E, 5.vi.1996, lowland rf. (RJK acc. 96.17) (w, ♀); Kirrama Ra., c. 9km W of Kennedy, 18°12'S, 145°52'E, 31.x.1999, primary rf. (SKR #808, 809) (w); Hinchinbrook I., Gayundah Ck, 18°21'S, 146°14'E, <100m, 8-18.xi.1984 (GBM) (w); Townsville, JCU Campus, 21.viii.1995 (SKR #2) (w); 30km N of Giru, 19°16'S, 147°03'E, 800ft, 6.vi.1980, gallery forest (BBL) (w, ♀); Conway Ra., Brandy Ck Rd., 20°21'S, 148°43'E, 21-23.iv.1975 (RJK acc. 75.187/7) (w); Pioneer Ck Pienic Ground, Gargett, W of Mackay, 21°09'S, 148°43'E, riparian rf. (SKR #65-67, 74-97 3) (w, ♀, ♂); ditto, 26.ii.1996 (SKR #363) (w); ditto, 15.v.1996 (SKR #379) (w); ditto, 29.v.1996 (SKR #385, 387, 391, 393) (w); ditto, 21.vii.1996 (SKR #411) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.50, 5.54-6.75; HL 1.68, 1.43-1.72; HW 1.64, 1.43-1.65; CI 98, 94-100; SL 2.06, 1.75-2.12; SI 126, 119-130; PW 1.31, 1.09-1.40; MTL 2.40, 1.96-2.46 (19 measured).

Clypeus in profile almost straight, weakly rounding posteriorly into moderately impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate with weakly raised margins; central area with weakly indicated frontal furrow. Sides of head in front of eyes almost straight, converging anteriorly and rounding into mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes convex, in full face view breaking lateral cephalic outline. Ocelli lacking, relative positions indicated by shallow but distinct depressions in cephalic sculpturation. Pronotum in dorsal view widest across narrowly rounded or bluntly angular humeri. Mesosoma in lateral view evenly convex; promesonotal suture distinct; position of metanotal groove weakly indicated by shallow depression in lateral outline; propodeum armed with pair of rather strong, diverging, blunt spines; propodeal declivity almost vertical. Petiole with anterior face weakly convex, posterior face rather strongly convex; dorsum armed with four acute spines, medial pair closer to each other than to lateral spines; lateral pair more slender, longer and strongly diverging. Subpetiolar process acute anteriorly, bluntly angular posteriorly. Anterior face of first gastral segment lower than height of petiole, widely rounding onto dorsum of segment.

Mandibles finely, mostly longitudinally rugose. Head, mesosoma, petiole and gaster finely shagreened with numerous minute punctures and

piliferous pits. Seulpturation relatively fine on dorsa of head, mesosoma and gaster; intensity of seulpturation distinetly inereasing laterally with sides of mesosoma distinetly reticulate and meso- and metapleurae rather strongly retieulate-rugose. Anterior face of petiole finely, mostly transversely reticulate dorsally, beeoming retieulate-rugose on lower parts.

Distinetly hairy. Numerous eurved and semiereet hairs arising from mandibular masticatory borders, numerous, very short, appressed hairs towards mandibular bases. Anterior clypeal margin with several long, anteriorly directed setae medially and fringe of shorter setae decreasing in length laterally. Several medium to long, erect or somewhat eurved, mostly paired hairs near anterior and basal elypeal borders, along frontal carinae and on vertex. Tuft of several hairs on summit of mesonotum with longest hairs reaehing greatest diameter of eye in length. Numerous ereet, medium length hairs on dorsal and ventral surfaces of gaster. Short, dense, appressed, decumbent or semiereet pubescenee on most body surfaces, distinctly diluted behind eyes towards oeeipital corners.

Colour. Blaek, including antennal seapes, eoxae and tarsi. Trochanters, femora and tibiae distinetly light to medium reddish-brown with proximal ends of tibiae a shade darker.

Qneen. Dimensions: TL e. 7.11-7.76; HL 1.65-1.87; HW 1.56-1.75; CI 93-98; SL 2.03-2.18; SI 123-130; PW 1.62-1.78; MT: 2.46-2.71 (5 measured). Apart from sexual characters, similar to worker exeept: pronotal humeri evenly rounded; mesoseutum distinetly wider than long with lateral margins converging anteriorly, forming narrowly rounded anterior margin; median line distinet; parapsides flat anteriorly, raised posteriorly; mesoscutum in profile with anterior margin widely rounded, dorsum flat. Mesoscutellum in profile weakly convex, marginally raised above dorsal plane of mesosoma; metanotal groove distinet. Propodeum armed with pair of distinet, dorsoventrally flattened, blunt spines. Lateral petiolar spines more slender and longer than dorsal pair. Sculpturation, pilosity and eolour virtually identical to that in worker.

Males and immature stages (eggs, larvae in various stages of development and pupae) deposited in thc QM spirit eollection.

REMARKS. *Polyrhachis monteithi* appears to be one of the most eommon *Cyrtomyrma* species in rainforests of north Queensland. Like most other speeies of the group it builds nests of silk and vegetation debris between the leaves of low rainforest trees and shrubs. It has also commonly been colleeted in relatively small rainforest patehes and gallery forests along rivers and ereeks. *Polyrhachis monteithi* is eharacterised by a distinetly hairy appearance that is shared by only one other Australian speeies, *P. pilosa*. *Polyrhachis monteithi* differs by its larger size (HL 1.43-1.72 versus 1.34-1.43 in *P. pilosa*) and distinet propodeal spines that are completely absent in *P. pilosa*. The known distribution of *P. monteithi* extends from about Cooktown south to Maekay, while *P. pilosa* is mostly a southern speeies extending from Mackay south to Taree in New South Wales and with only a few isolated eollections from north Queensland. *Polyrhachis monteithi* was listed as *P.* '*Cyrto* 03' by Kohout (2000: 196).

Polyrhaehis pilosa Donisthorpe, 1938
(Fig. 4E-F)

'Polyrhachis rastellata r. *laeviar* var. *pilosa'* Forel, 1902: 527. (Unavailable name)

Palyrhachis (Cyrtomyrma) rastellata var. *pilosa* Donisthorpe, 1938: 256. First available use of *'P. rastellata laevior pilosa'* Forel (original speeimens from Wollongbar, Riehmond R. NEW SOUTH WALES (Froggatt) aceepted as syntypes by Donisthorpe), (AMNH) (examined).

Polyrhachis pilosa Donisthorpe; Kohout & Taylor, 1990: 518. Raised to speeies.

Polyrhachis (Cyrtomyrma) pilosa Donisthorpe; Kohout, 2000: 195.

REMARKS. *Polyrhachis pilosa* is similar to *P. mackayi*, both having an evenly eonvex mesosomal dorsum, a completely unarmed propodeum and subequal petiolar spines. However, the former is easily distinguished by the cover of relatively long, erect hairs on the dorsum of the head and mesosoma (Fig. 4E-F). The main distribution of *P. pilosa* is similar to that of *P. mackayi*, reaehing its southern limit at about Taree in northern New South Wales. In the north *P. pilosa* appears to be rather patchily distributed, with confirmed reeords from around Townsville and as far north and west as Fourty Mile Scrub and Undara (ANA). It is a relatively common speeies within its main range and rather opportunistic in chosing its nesting sites. In recent years this species has become increasingly common in suburban parks and gardens, with their silk nests built not only between leaves, but also in various artificial cavities around houses, including door and window frames.

Polyrhachis robsoni sp. nov.
(Fig. 3B, F-G)

MATERIAL. HOLOTYPE: QUEENSLAND, Daintree R. x-ing, 16°15'S, 145°23'E, 9.ix.2001, riparian rf., R.J. Kohout acc. 2001.26 (worker). PARATYPES: data (and nest) as for holotype (61 workers, 4 dealate ♀♀); ditto, 16.vi.1997, S.K. Robson #559 (47 workers, dealate ♀). Type deposition: Holotype (QMT99339), most paratype workers, 3 paratype ♀♀ (from holotype nest) and paratype workers and paratype ♀ in QM; 2 paratype workers, 1 paratype ♀ (from holotype nest) and 3 paratype workers in ANIC, 2 paratype workers (from holotype nest) in AMNH, BMNH, CASC, JCUT, MCZC, MHNG, MLAC and NMNH. OTHER MATERIAL: QUEENSLAND, Torres Strait, Thursday I., 10°35'S, 142°13'E, 27.ix.2003, monsoonal rf. (RJK accs 03.20, 22, 23, 24, 25, 26, 27) (w, ♀); Home Rule, 15°45'S, 145°17'E c. 200m, 9-11.vi.1996, rf. edge (CJB & RJK acc. 96.43) (w); Mt Hartley, 15°46'S, 145°19'E, 200-500m, 11.vi.1996, rf. (CJB & RJK acc. 96.45) (w); Shiptons Flat, 35km S of Cooktown, 15°47'S, 145°13'E, 16.vi.1997, second. rf. (SKR #591) (w); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°25'E, 12-15.vi.1996 (RJK acc. 96.47) (w); Cape Tribulation N.P., 16°04'S, 145°27'E, 6.xii.1985, rf. (RJK acc. 85.6) (w, ♂); ditto, 19.x.1980, rf. (GBM et al.) (w); ditto, Canopy Crane site, 16°06'S, 145°27'E, 20-21.ii.2000, rf. (RJK & SKR acc. 2000.40) (w, ♀, ♂); Noah Ck, 13-19.x.1980 (GBM) (w); Oliver Ck, 16°08'S, 145°26'E, 14.vi.1996, rf. (RJK acc. 96.53) (w); Cow Bay, S of Cape Tribulation, 16°14'S, 145°28'E, 16.vi.1997, second. rf. (SKR #587) (w); Daintree R. x-ing, 16°15'S, 145°23'E, 16.vi.1997, riparian rf. (SKR #559.560) (w); Oak Beach, 16°36'S, 145°31'E, 10m, 18.v.1998, pyrethrum (GBM #1895) (w); Caravonica, 10km NW of Cairns, 16°51'S, 145°41'E, second. rf. & urban gardens (SKR numerous dates & accessions) (w, ♀, ♂); Cairns, Lake Placid, 16°52'S, 145°40'E, 18.x.1995 (SKR #57) (w); Cairns, Stratford Environ. Park, 16°53'S, 145°44'E, 13.i.1992 (RJK acc. 92.1) (w); Cairns, Botanic Gdns, 16°54'S, 145°45'E, (SKR numerous dates & accessions – see below under remarks) (w, ♀, ♂); ditto, 20.ii.2000 (RJK & SKR accs 2000.13, 14) (w); Yarrabah, c. 11km E of Cairns, 16°54'S, 145°51'E, 1-2.iii.1996, primary lowland rf. (SKR #371, 424) (w); Bellenden Ker, Cableway Base Stn, 8-23.iv.1987 (E. Dahms & G. Sarnes) (w); Russel R., Bellenden Ker Landing, 1-9.xi.19981 (GBM & Earthwatch Exp.) (w); Babinda, Double Barrel Ck, 17°21'S, 145°56'E, 26.i.1994, rf. (C.J. Hill); Garradunga, Seymour Ra., c. 7km N of Innisfail, 17°28'S, 146°01'E, <100m, 5-6.vi.1996, lowland rf., (RJK acc. 96.31 (w); nr Clump Point, NE of Tully, 30.iv.1969 (RWT acc. 69.103) (w); Mission Beach-El Arish Rd, 17°52'S, 146°04'E, 5.vi.1996, lowl. rf. (SKR #405) (w, ♀); ditto, 4.xii.1996, lowland rf. (SKR #803) (w); c. 2km W of Sth Mission Beach, 17°52'S, 146°05'E, 18-19.vii.1980, lowl. rf. (RJK acc. 80.90) (w); 10km WbyN of Sth Mission Beach, 17°56'S, 146°00'E, 18-19.vii.1980, lowl. rf. (RJK acc. 80.57) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 5.85, 5.29-6.50; HL 1.47, 1.40-1.59; HW 1.50, 1.40-1.59; CI 102, 95-102; SL 1.75, 1.68-1.93; SI 117, 115-126; PW 1.18, 1.09-1.34; MTL 2.00, 1.87-2.21 (32 measured).

Clypeus in profile virtually straight, abruptly rounding posteriorly into moderately impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate, margins moderately raised; central area weakly concave with distinct frontal furrow. Sides of head in front of eyes weakly convex, converging anteriorly towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes convex, in full face view breaking lateral cephalic outline. Ocelli lacking, relative positions of lateral ocelli indicated by shallow depressions in cephalic sculpturation. Pronotum in dorsal view widest just behind humeri that are toothed or, at least, angular. Mesosoma in profile strongly convex; promesonotal suture distinct; position of metanotal groove indicated by rather distinct depression; declivity very steep, almost vertical. Petiole with anterior face very weakly convex, posterior face moderately convex; dorsum armed with four spines; dorsal pair closer to each other than to lateral spines; lateral pair distinctly longer, more slender and rather strongly diverging.

Mandibles very finely, mostly longitudinally rugose with numerous, shallow punctures and piliferous pits. Head and gaster finely, dorsum of mesosoma and petiole more coarsely, shagreened. Sides of mesosoma rather strongly sculptured with intensity increasing laterally, meso- and metapleurae rather strongly reticulate-rugose. Anterior and posterior faces of petiole somewhat transversely wrinkled dorsally with sculpturation becoming coarsely rugose on lower parts. Numerous minute, mostly piliferous punctures over all body surfaces.

Mandibular masticatory border with numerous, curved and subercct hairs. Anterior clypeal margin medially with 1 long and a few shorter, anteriorly directed setae, fringe of shorter setae lining margin laterally. Several, mostly paired hairs arising near anterior and basal clypeal margins, along frontal carinae and on vertex. Generally only 2, erect, straight or undulated hairs, shorter than longest diameter of eye, on summit of mesonotum. Gastral dorsum with medium length, more-or-less erect hairs lining posterior margins of apical segments; hairs distinctly more abundant on venter of gaster. Abundant, mostly appressed hairs arising from

numerous punctures and pits on most dorsal body surfaces.

Colour: Black; very narrow band along mandibular masticatory borders, condylae and extreme tips of apical funicular segments, reddish-brown. Most of antennae and tarsi black or very dark brown. Trochanters, femora and tibiae generally light to medium reddish-brown with distal ends of femora and tibiae narrowly, and proximal ends of tibiae more widely, dark brown.

Queen. Dimensions: TL c. 6.60-8.82; HL 1.56-1.96; HW 1.47-1.96; CI 94-102; SL 1.78-2.28; SI 112-121; PW 1.43-2.00; MTL 2.03-2.74 (5 measured). Apart from sexual characters, resembling worker except: pronotal humeri narrowly rounded; mesoscutum only marginally wider than long; lateral margins converging anteriorly into rather widely rounded anterior margin; median line distinctly bifurcate posteriorly; parapsides weakly raised posteriorly; mesoscutum in profile with widely rounded anterior face, flat dorsally. Mesoscutellum weakly convex in profile, moderately raised above dorsal plane of mesosoma; metanotal groove distinct. Propodeum armed with pair of short, strongly upturned teeth that are completely lacking in all workers examined. Petiole in profile bi-convex and spines, notably lateral pair, distinctly shorter than in worker. Remaining features, including sculpturation and colour, as in worker.

Males and immature stages (eggs, larvae and pupae) in QM and JCUT collections.

REMARKS. *Polyrhachis robsoni* is a rather common north Queensland species distributed from Cooktown south to Mission Beach. It also occurs on Thursday Island in Torres Strait with this isolated population characterised by small workers (HL 1.40-1.47 versus 1.47-1.59 in mainland specimens). In addition, all Thursday Island colonies collected have shown polygyny and queen polymorphism. In two colonies the queens were distinctly both maco- and microgynous, while another colony contained only microgynous queens. Yet another colony included a graded series of numerous intermediates between the 'normal' macrogynous and microgynous queens seen in the other colonies. Queen size polymorphism in the mainland populations of *P. robsoni* is under investigation by Robson, Crozier, Henshaw & van Zweden at James Cook University, Townsville. Thirty seven nests of *P. robsoni* were collected by Robson at the Cairns Botanic Gardens (16°54'S, 145°45'E), of which 18 were polygynous. In 12 nests queens were of both sizes, in 4 they were only macrogynous and in the remaining 2 nests they were only microgynous. *Polyrhachis robsoni* is characterised by a highly arched mesosoma, toothed or distinctly angular pronotal shoulders and a completely unarmed propodeum. This species builds polydomous nests between leaves on the lower branches of trees and shrubs in lowland and riparian rainforests. Colonies on Thursday I. were found nesting in a small patch of dry monsoonal rainforest. This species was listed by Kohout (2000: 196) as both *P.* '*Cyrto* 04' and *P.* '*Cyrto* 05'.

Polyrhachis rutila sp. nov.
(Fig. 3C, H-I)

MATERIAL. HOLOTYPE: QUEENSLAND, Davies Ck, c. 17km E of Mareeba, 17°01'S, 145°35'E, 15.vi.1980, rf. edge, R.J. Kohout acc. 80.19 (worker). PARATYPES: data as for holotype (9 workers). Type deposition: Holotype (QMT99340) and 3 paratypes in QM, 2 paratypes each in ANIC, BMNH and MCZC.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 4.94, 4.89-5.19; HL 1.31, 1.28-1.37; HW 1.31, 1.28-1.37; CI 100, 98-101; SL 1.43, 1.43-1.56; SI 109, 109-117; PW 0.97, 0.90-1.03; MTL 1.75, 1.68-1.81 (9 measured).

Anterior clypeal margin with central flange broadly emarginate medially and flanked by minute denticles. Clypeus in profile straight for most of its length, posteriorly curving abruptly into well impressed basal margin. Frontal triangle indistinct. Frontal carinae rather short, sinuate, with moderately raised margins; frontal furrow represented by more-or-less distinct, weakly raised, longitudinal carina. Sides of head in front of eyes almost straight, strongly converging into mandibular bases; behind eyes sides rounding into convex occipital border. Eyes relatively large, moderately convex, in full face view just reaching lateral cephalic outline. Median ocellus rather obscure, lateral ocelli lacking, relative positions indicated by shallow depressions in cephalic sculpturation. Pronotum in dorsal view with humeri rounded; greatest pronotal width at or near mid-length of segment. Mesosoma in profile with anterior face of pronotum convex; dorsum weakly concave with well impressed promesonotal suture; mesonotum convex; metanotal groove indistinct, indicated in some specimens by rather shallow depression in outline. Petiole with anterior face almost straight, posterior face moderately convex; dorsum armed with four short, acute, subequal teeth. Subpetiolar process

acute anteriorly, angular posteriorly. Anterior face of first gastral segment with base weakly concave, narrowly rounding onto dorsum of segment.

Mandibles very finely, mostly longitudinally rugose with numerous shallow punctures and piliferous pits. Head, mesosoma and gaster very finely shagreened, sculpturation on sides of mesosoma and petiole more distinct, reticulate on meso- and metapleurae and both faces of petiole. Rather dense piliferous pits and shallow punctures covering all body surfaces.

Mandibular masticatory borders with a few, rather short, curved hairs. Anterior clypeal margin usually with 1 long and 2 shorter, anteriorly directed setae medially and numerous shorter setae fringing margin laterally with their lengths decreasing towards madibular bases. Several medium length, erect, mostly paired hairs arising near anterior and basal clypeal margins, along frontal carinae, on vertex and around apex of gaster. Hairs virtually absent from mesosoma, petiole and most of gastral dorsum. Very short, mostly appressed or decumbent pubescence arising from pits over all body surfaces, denser patches of more erect hairs on propodeum, petiole and venter of gaster.

Body generally light to medium reddish-brown with sides of mesosoma and petiole distinctly darker. Mandibular masticatory borders, condylae and gaster light yellow. Antennae reddish-brown with distal ends of scapes and apical segments of funiculi distinctly lighter. Anterior and basal clypeal margins, frontal carinae and genal carina narrowly lined with dark brown or black. Coxae and subpetiolar process light reddish-brown. Legs generally light yellow with proximal ends of tibiae and tarsi a shade darker.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis rutila* is known only from the type locality with all specimens collected by a single sweep of low foliage along the rainforest edge. This remarkable species is characterised by the outline of mesosoma which has a weakly concave summit and strongly impressed promesonotal suture. The brownish coloration of *P. rutila* is unlike all the other Australian *Cyrtomyrma* species that are jet-black. It is possible that the specimens of *P. rutila* are not fully pigmented, however, they appear fully sclerotised and the colour pattern is constant in all individuals. *Polyrhachis rutila* was listed by Kohout (2000: 197) as *P.* '*Cyrto*' 07'.

Polyrhachis yorkana Forel, 1915
(Fig. 4G-H)

Polyrhachis (Cyrtomyrma) rastellata var. *yorkana* Forel, 1915: 110; Donisthorpe, 1938: 257. Syntype workers. Type locality: QUEENSLAND, Cape York Peninsula (E. Mjöberg), MHNG, NRMS, BMNH, ANIC, QM (examined).

Polyrhachis yorkana Forel. Kohout & Taylor, 1990: 521. Raised to species.

Polyrhachis (Cyrtomyrma) yorkana Forel. Kohout, 2000: 196.

REMARKS. *Polyrhachis yorkana* is somewhat similar to *P. debilis* from New Guinea, with both displaying considerable variability in the development of the propodeal spines which range from inconspicuous tuberculae to short spines. However, they differ in numerous characters differ, including the shape of the head, which in *P. debilis* is as wide or even wider than long (CI 100-103), while in *P. yorkana* it is distinctly longer than wide (CI 96-98). In full face view, the eyes of *P. debilis* do not reach the sides of the head, while in *P. yorkana* they clearly break the cephalic outline. In lateral view, the pronotum is distinctly convex in *P. debilis* and rather flat in *P. yorkana*. In dorsal view, the pronotum in *P. debilis* is relatively narrow with evenly rounded shoulders, while in *P. yorkana* the pronotum is distinctly widest just behind the shoulders and, in the majority of specimens examined, the pronotal humeri are subangular (Fig. 4H) or distinctly angular. They also differ in their relative size, with *P. debilis* distinctly smaller (HL 1.34-1.47) compared to *P. yorkana* (HL 1.56-1.62). *Polyrhachis yorkana* is largely confined to the Wet Tropics of north Queensland, but it has occasionally been collected further north on Cape York Peninsula. It is an arboreal species with all colonies observed occupying polydomous silk nests built between the leaves of lowland rainforest trees.

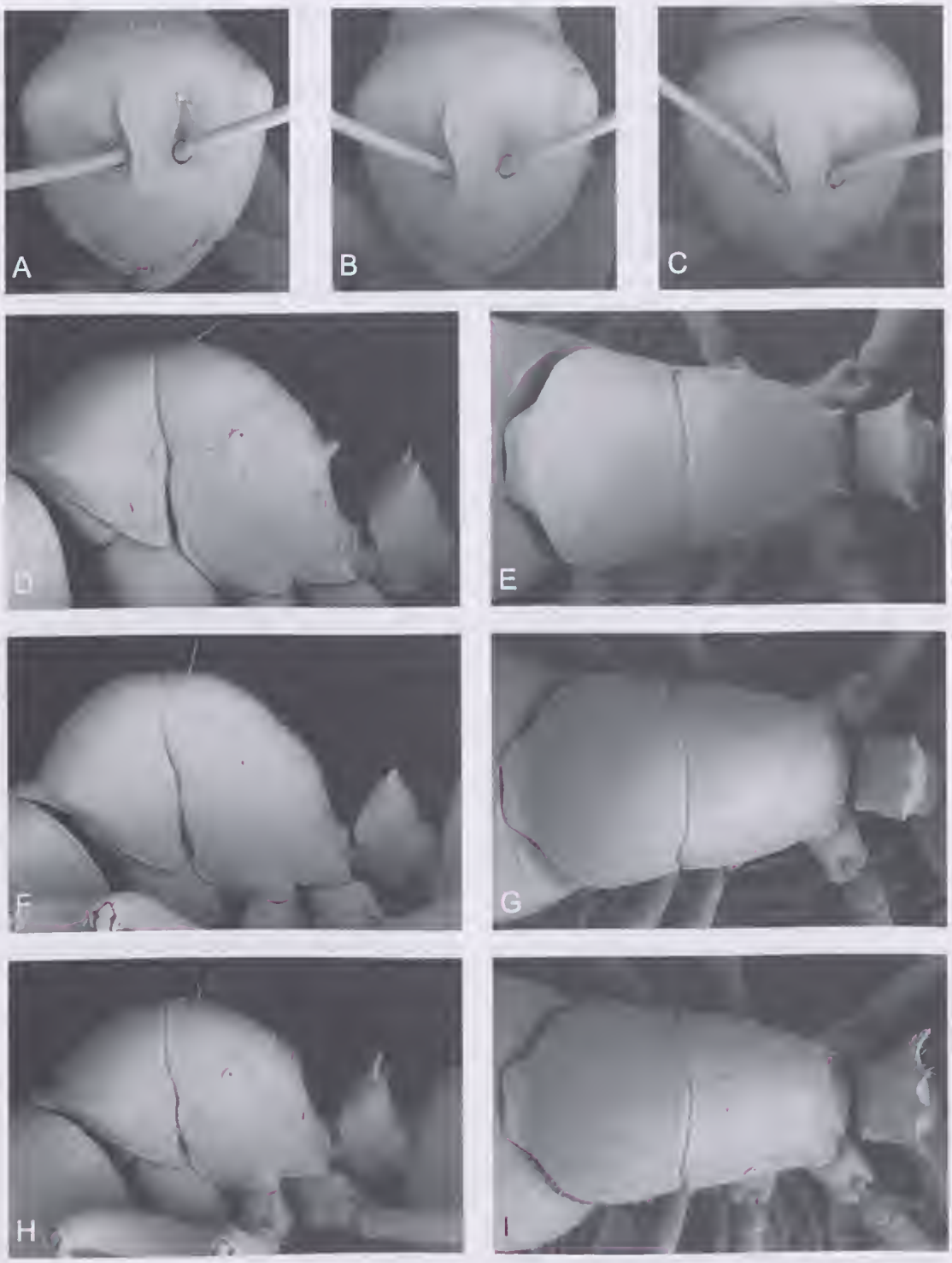


FIG. 1. *Polyrhachis (Cyrtomyrma)* speeies from Australia, Head in full faee view (top); lateral view of mesosoma and petiole (left); dorsal view of mesoma and petiole (right). A, D-E, *P. abbreviata* sp. nov.; B, F-G, *P. brevinoda* sp. nov.; C, H-I, *P. decumbens* sp. nov.

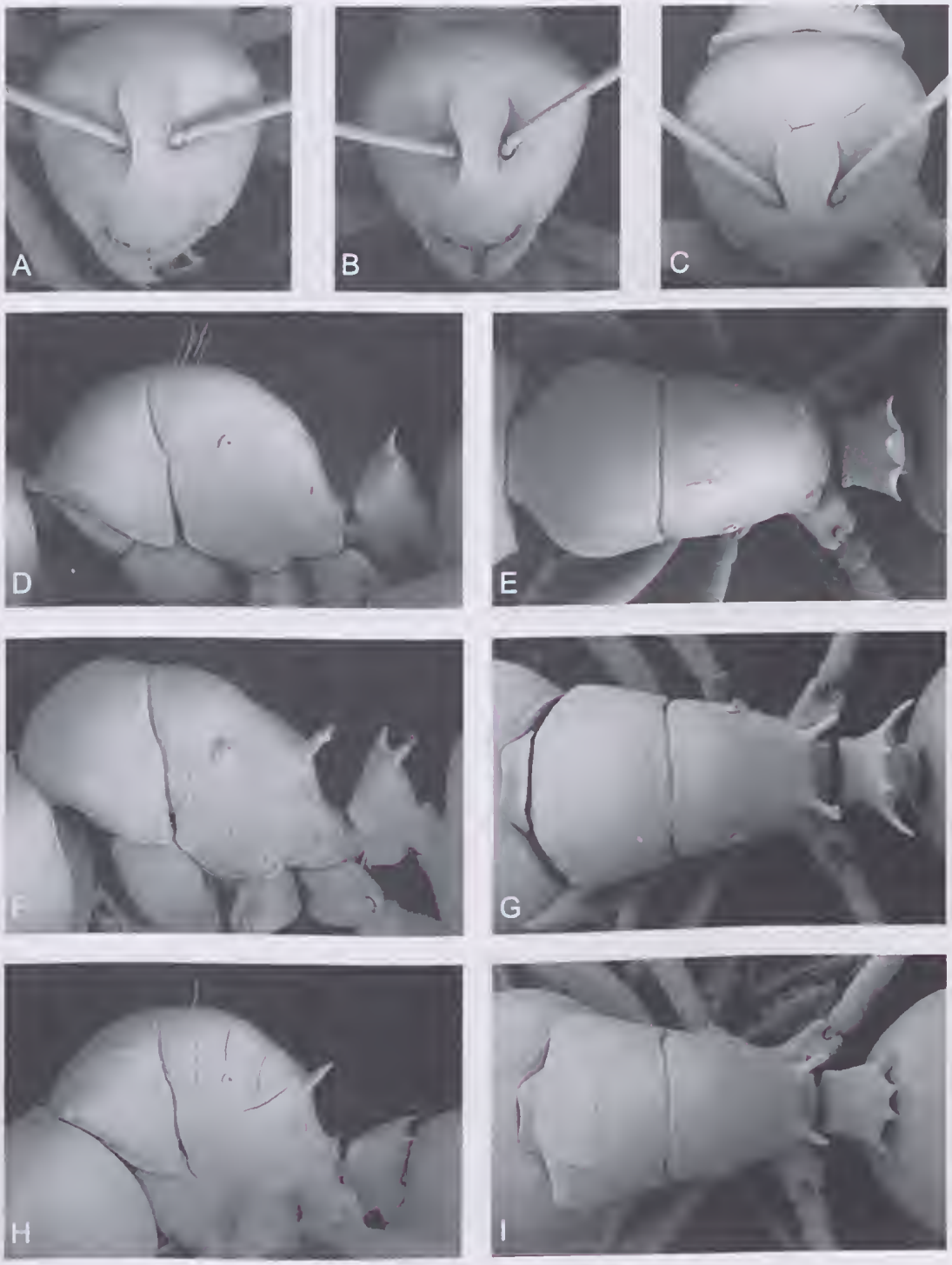


FIG. 2. *Polyrhachis (Cyrtomyrma)* species from Australia, Head in full face view (top); lateral view of mesosoma and petiole (left); dorsal view of mesoma and petiole (right). A, D-E, *P. delecta* sp. nov.; B, F-G, *P. expressa* sp. nov.; C, H-I, *P. hoelldobleri* sp. nov.

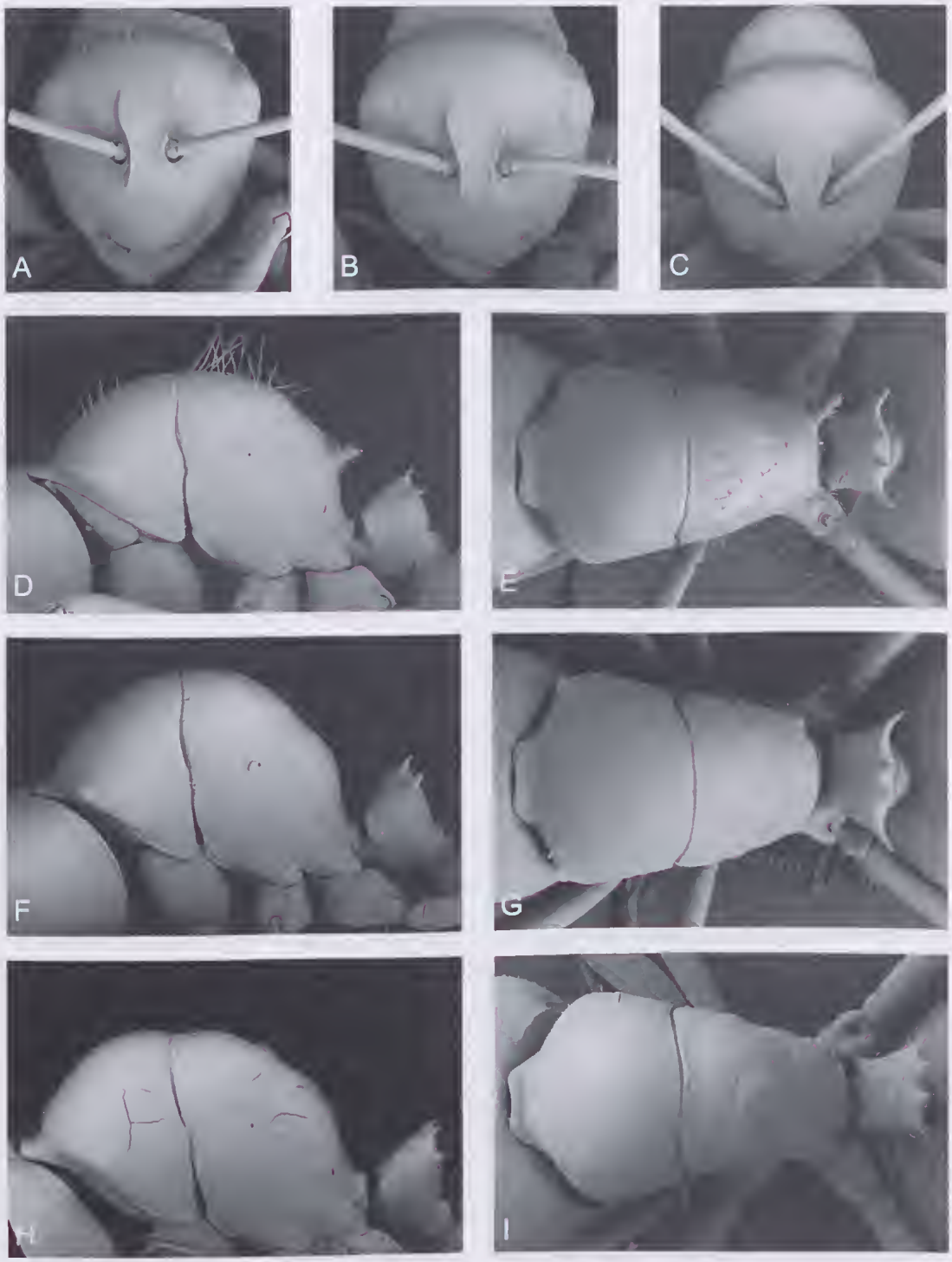


FIG. 3. *Polyrhachis (Cyrtomyrma)* species from Australia. Head in full face view (top); lateral view of mesosoma and petiole (left); dorsal view of mesoma and petiole (right). A, D-E, *P. monteithi* sp. nov.; B, F-G, *P. ronsoni* sp. nov.; C, H-I, *P. rutila* sp. nov.

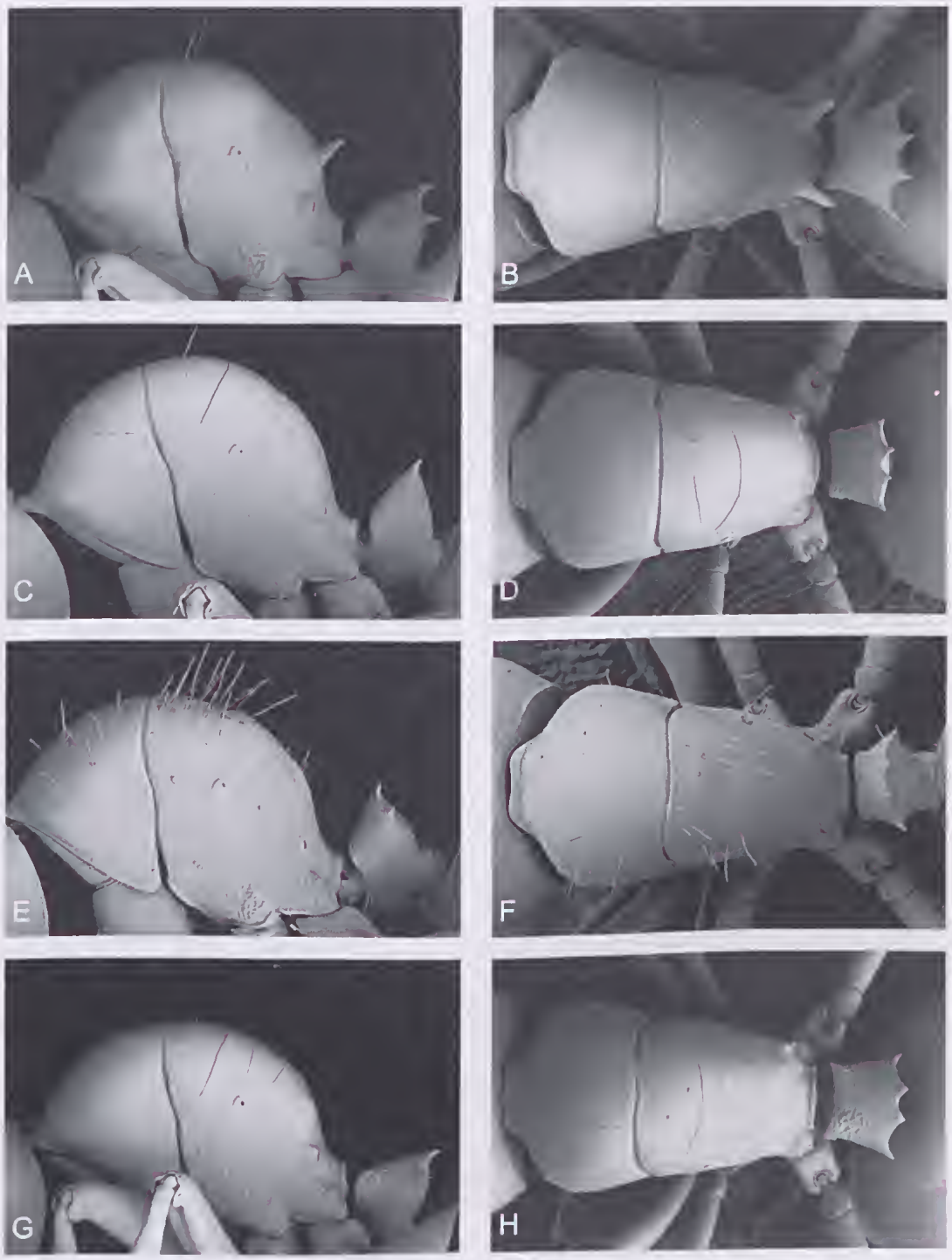


FIG. 4. *Polyrhachis (Cyrtomyrma)* species from Australia, Lateral view of mesosoma and petiole (left); dorsal view of mesoma and petiole (right). A-B, *P. australis* Mayr; C-D, *P. mackayi* Donisthorpe; E-F, *P. pilosa* Donisthorpe; G-H, *P. yorkana* Forel.

CHECKLIST OF *CYRTOMYRMA* SPECIES FROM BORNEO

The following list includes all *Cyrtomyrma* species known to occur on Borneo. It also includes *P. rastellata* (in parentheses in the list and key) that has been listed from Borneo by several authors but is, in my opinion, unconfirmed from the island.

P. achterbergi sp. nov.
P. bruehli sp. nov.
P. danum sp. nov.
P. laevissima Fr. Smith
P. lepida sp. nov.
(*P. rastellata* (Latreille))
P. sulang sp. nov.
P. widodoi sp. nov.

KEY TO *CYRTOMYRMA* SPECIES FROM BORNEO (BASED ON WORKER CASTE)

1. Pronotal shoulders produced into distinct teeth (Figs 6B, 6D, 7F) 2

   Pronotal shoulders without distinct teeth, narrowly or broadly rounded or bluntly angular (Figs 6F, 7B, 7D) . 6

2. Head, mesosoma, petiole and gaster finely shagreened, jet-black 3

   Head, mesosoma and petiole distinctly reticulate-punctate, opaque, distinctly blue or with bluish sheen 4

3. Mesosoma in profile strongly convex anteriorly; mesonotum, propodeum and declivity descending posteriorly in an almost straight line (Fig. 6G); petiolar spines reduced to obtuse teeth ..... *laevissima* Fr. Smith

   Mesosoma in profile moderately convex; mesonotum and propodeum descending posteriorly in weakly convex line before abruptly sloping into steep declivity (Fig. 7E); petiole with elongate lateral spines ..... *sulang* sp. nov

4. Propodeum armed with pair of short spines (Fig. 6C); petiole with pair of elongated lateral spines, dorsal pair lacking (Fig. 6D) ..... *bruehli* sp. nov.

   Propodeal dorsum unarmed (Fig. 6A); petiole with pair of dorsal blunt teeth and pair of distinctly longer lateral spines (Fig. 6B) ..... 5.

5. Anterior clypeal margin with central, blunt, projecting tooth (Fig. 5A) ..... *achterbergi* sp. nov.

   Anterior clypeal margin deeply emarginate medially (Fig. 5B) ..... *widodoi* sp. nov.

6. Larger species (HL >1.65); pronotal shoulders widely rounded (Fig. 6F); petiole with sides more-or-less parallel, spines reduced to minute denticles (Fig. 6F) ..... *danum* sp. nov

   Smaller species (HL <1.65); pronotal shoulders narrowly rounded or angular (Fig. 7B, D); petiole with sides diverging, spines acute (Fig. 7B, D) 7

7. Lateral petiolar spines distinctly longer than dorsal pair (Fig. 7B); legs dark reddish-brown ... *lepida* sp. nov.

   Petiolar spines subequal or lateral pair shorter than dorsal pair (Fig. 7D); legs mostly orange or light reddish-brown ..... (*rastellata* (Latreille))

Polyrhachis achterbergi sp. nov. (Figs 5A, 6A-B)

MATERIAL. HOLOTYPE: EAST MALAYSIA, SABAH, Danum Valley Conservation Area, 04°57'N, 117°48'E, Segama R. trail, c. 150m, rf., 11.xi.2000, R.J. Kohout aec. 2000.217 (worker). PARATYPES: data as for holotype (2 workers); nr Danum Valley Field Centre, c. 150m, 20-26.iii.1987, Malaise Trap 5, C.van Achterberg (3 workers); ditto, C.van Achterberg & D. Kennedy (2 workers); ditto, Malaise Trap 10, C.van Aehterberg (worker); ditto, 14.x.1999, fogging, L. Ellwood (T1 – fog 4-2; fog 4-17; fog 4-20; fog 4-24) (5 workers). Type deposition: Holotype (QMT99341) and 1 paratype in QM; 2 paratypes in ANIC, BMNH, MCZC and RMNH; 1 paratype each in CASC and ITBC.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 8.06, 7.46-8.06; HL 2.25, 2.12-2.25; HW 2.28, 2.15-2.28; CI 101, 101-105; SL 2.09, 2.03-2.18; SI 92, 91-99; PW 1.78, 1.68-1.81; MTL 2.71, 2.62-2.81 (14 measured).

Anterior clypeal margin convex with central, blunt, projecting tooth. Clypeus in profile very weakly sinuate, almost straight, with weakly impressed basal margin; laterally basal margin indicated by very distinct line. Frontal triangle weakly impressed. Frontal carinae relatively short, margins only weakly raised; central area wide with distinct, flat frontal line. Head very broad, distinctly wider than long. Sides of head almost straight in front of eyes; widely rounding behind eyes into broad, medially concave occipital margin. Lateral carina separating gena from ventral parts of head lacking. Eyes relatively small, rather flat, situated well forward and inward from occipital corners; in full face view eyes not reaching lateral cephalic outline. Median ocellus distinct; lateral ocelli absent, relative positions indicated by slightly raised cephalic sculpture. Pronotum in dorsal view with humeri armed with strong, blunt teeth. Mesosoma in profile convex anteriorly, summit relatively flat, posteriorly sloping in weakly convex curve into very short propodeal declivity; promesonotal suture distinct; metanotal groove lacking. Petiole with weakly convex anterior, and virtually flat posterior face; dorsum armed with pair of broad-based, blunt teeth and pair of longer, slender lateral spines. Subpetiolar process angular anteriorly, widely rounded posteriorly. Anterior face of first gastral

segment relatively low and flat, widely rounding onto dorsum of segment.

Mandibles very finely, mostly longitudinally, striate-rugose with numerous shallow piliferous pits. Clypeus with smooth, median line, running from anterior clypeal process towards base, reaching weakly impressed frontal triangle. Most of head, mesosoma and petiole distinctly and regularly reticulate-punctate. Gaster very finely shagreened.

Several short, curved hairs present on mandibular masticatory borders, a number of short, appressed hairs arising from pits towards mandibular bases. Only a few, rather short, anteriorly directed setae fringing anterior clypeal margin. Short to very short, erect hairs, mostly in pairs, near anterior and basal clypeal margins and along frontal carinae; 1 or 2 pairs of short hairs on summit of mesosoma. Gaster with several medium length hairs lining posterior margins of apical segments, with hairs more abundant on venter. Extremely short, closely appressed pubescence over all body surfaces, most distinct on gaster.

Head, mesosoma and petiole medium to deep blue with weak metallic sheen. Mandibles black with small reddish patch near masticatory borders. Antennae brown with distal end of scapes blotched reddish-brown. Funicular segments very narrowly at their joints, and tips of apical segments widely, yellowish-brown. Coxae of front legs and subpetiolar process medium reddish-brown, coxae of mid- and hind legs a shade lighter; rest of legs very bright, light to medium orange; proximal ends of tibiae and tarsi very dark brown to black. Gaster very dark reddish-brown, almost black in some specimens, with posterior margins of segments diffusely reddish-brown.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis achterbergi* is known only from the type locality where it is sympatric with *P. bruehli* and *P. widodoi*, both described below. Nothing is known about its nesting habits but most specimens have been collected by fogging or Malaise traps and it is apparently arboreal, probably building nests high in the rainforest canopy. *Polyrhachis achterbergi* is a spectacular species, the blue colour of the head, mesosoma and petiole, strongly contrasting with the orange appendages. It is similar to *P. bruehli* (Fig. 6C-D) and *P. widodoi*, and also to *P. vitalisi* (Fig. 7G-H), described by Santschi (1920: 567) from Laos. All four species share the dense reticulate-punctate sculpturation of the head, mesosoma and petiole but only *P. achterbergi*, *P. bruehli* and *P. widodoi* have the same striking colour scheme. *Polyrhachis achterbergi* differs from *P. bruehli* by the absence of propodeal spines and from *P. widodoi* by shape of the anterior clypeal margin. In *P. achterbergi* the margin has a central, blunt, projecting tooth (Fig. 5A), while in *widodoi* it is deeply emarginate medially (Fig. 5B).

Polyrhachis bruehli sp. nov.
(Fig. 6C-D)

MATERIAL. HOLOTYPE: EAST MALAYSIA, SABAH, Danum Valley, i-iv.1999, fogging, C. Brühl (worker). Type deposition: Unique holotype (QMT99342) in QM.

DESCRIPTION. *Worker*. Dimensions of holotype: TL c. 6.55; HL 1.78; HW 1.81; CI 102; SL 1.78; SI 98; PW 1.40; MTL 2.34.

Anterior clypeal margin broadly and shallowly emarginate medially; emargination flanked by distinct, anterolaterally projecting, acute teeth. Clypeus in profile straight with basal margin flat; shallow median depression on clypeus near basal margin, may be due to partly collapsed cuticula as holotype is probably not fully sclerotised. Frontal triangle shallowly impressed; frontal carinae sinuate, relatively short with only weakly raised, posteriorly converging margins; central area wide with distinct longitudinal furrow terminating in shallow depression on vertex that indicates position of median ocellus. Head broad, wider than long. Sides of head in front of eyes almost straight, converging towards mandibular bases; behind eyes sides rounding into broad, medially weakly concave occipital margin. Eyes weakly convex, situated well forward and inward from occipital corners; in full face view eyes not reaching lateral cephalic outline. Ocelli lacking. Pronotal humeri armed with short, acute spines; lateral margins below spines narrowly emarginate. Mesosoma in profile convex; promesonotal suture distinct; metanotal groove lacking; propodeum armed with pair of short, acute, triangular, upturned spines. Petiole narrow in profile; dorsum armed with long, posteriorly curved, lateral spines; dorsal spines lacking. Anterior face of first gastral segment shallowly concave at base.

Mandibles very finely, mostly longitudinally rugose with numerous piliferous pits. Clypeus with smooth, weakly indicated, median line, running from anterior clypeal process towards base, reaching shallowly impressed frontal triangle. Body sculpturation consisting of regular reticulate-puncturation, uniformly distributed on

head, mesosoma and petiole. Gaster very finely shagreened.

A few, short, curved and semicrect hairs on mandibular masticatory borders. Anterior clypeal margin medially with 1 long and 2 shorter, anteriorly directed setae; fringe of shorter setae lining margin laterally. Medium length, erect hairs, mostly in pairs, near anterior and basal clypeal margins and along frontal carinae. Gaster with several medium length hairs lining posterior margins of apical segments, hairs more abundant on venter. Hairs completely absent from vertex, mesosoma and petiole. Extremely short, closely appressed pubescence distributed sparingly over all dorsal body surfaces.

Body generally reddish-brown with dorsum of head, mesosoma and petiole with distinct blue sheen. Mandibles, antennae, including condylae, coxae and legs very light yellow; mandibular teeth and apical segments of tarsi a shade darker.

REMARKS. The holotype is the only known specimen of this remarkable species. It appears to be not fully pigmented and sclerotised, with the gaster and possibly also the median portion of clypeus collapsed. *Polyrhachis bruehli* resembles *P. achterbergi* and *P. widodoi* but differs from both by the presence of short, but distinct propodeal spines and by the configuration of the petiolar spines. It also differs in the shape of anterior clypeal margin that is shallowly and widely emarginate with the emargination flanked by distinct, anterolaterally projecting, acute teeth.

Polyrhachis danum sp. nov.
(Fig. 6E-F)

MATERIAL. HOLOTYPE: EAST MALAYSIA, SABAH, Danum Valley Conservation Area, 04°57'N, 117°48'E, Segama R. Trail, rf., 11.xi.2000, R.J. Kohout acc. 2000.217 (worker). PARATYPES: data as for holotype (21 workers, 1 dealate ♀); ditto, Nature Trail, rf, 11.xi.2000, RJK acc. 2000.227 (2 workers); ditto, Western Trail, rf, 12.xi.2000, RJK acc. 2000.237 (12 workers). Type deposition: Holotype (QMT99343), most paratype workers and paratype ♀ in QM; 2 paratypes each in AMNH, ANIC, BMNH, BPBM, CASC, ITBC, MCZC and NMNH. OTHER MATERIAL: EAST MALAYSIA, SABAH, Maliau Basin Cons. Area, Agathis Camp, 04°41'S, 116°54'E, c.500m, 16-19.iii.2005, rf. (RJK & Lina Thomas acc. 05.87 (w, ♀); Sepilok For. Reserve nr Sandakan, 10.-12.vi.1968, rf. (RWT accs 68.408, 428, 441) (w); Lambuk Rd, 45mi ex Sandakan (Lungmanis), 12.-13.vi.1968 (RWT acc. 68.452) (w); W coast Residency Ranau, 8km N of Poring Hot Springs, 500m, 8-18.x.1959 (T.C. Maa) (w); nr Danum Valley Field Centre, c. 150m, 11.& 14.-20.iii.1987, Malaise Trap (C.van Achterberg) (w); Danum Valley, 04°57'N, 117°48'E, 1994 (Maryati Mohamed) (w); ditto, fogging, xi.1995 (E. Widodo) (w); ditto, vi.1996 (E. Widodo) (w); Deramakot Forest Reserve, i-v.1998 (C. Brühl) (w); Forest Camp, 19km N of Kalabakan, 180m. 12.& 22.x.1962 (Y. Hirashima) (w); Quoin Hill, Tawau, 9.viii.1962 (Y. Hirashima) (w). SARAWAK: Bau Distr., Bidi, 90-240m, 3.ix.1958 (T.C. Maa) (w). BRUNEI: Temburong Distr., Kuala Belalong Field Study Centre, 15.iv.1993, rf. (RJK acc. 93.5) (w); Belait Distr., Kuala Ingai, Ulu Belait, 12.-15.vii.1994, rf. (RJK acc. 94.114) (w); Bukit Sulang, nr Lamunin, 20.viii-10.ix.1982, fogging (N.E. Stork, B.M. 1982-388) (w). INDONESIA, KALIMANTAN, 17-46km W of Batulitjin, 28.vi.- 2.vii.1972, lowl. rf. (W.L. Brown) (w); Gunning Palung Nat. Pk, Cabang Panti Res. Stn, 01°15'S, 110°5'E, 100-400m, 15.vi-15.viii.1991, primary rf. (Darling, Rosichon & Sutrisno) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 7.76, 6.60-7.76; HL 1.84, 1.65-1.87; HW 1.62, 1.37-1.62; CI 88, 81-88; SL 2.50, 2.18-2.50; SI 154, 150-164; PW 1.37, 1.22-1.37; MTL 3.12, 2.68-3.17 (31 measured).

Clypeus in profile weakly, evenly convex with basal margin weakly impressed. Frontal triangle indistinct. Frontal carinae sinuate with raised margins; central area concave with weakly indicated frontal furrow. Sides of head in front of eyes weakly convex, converging anteriorly towards mandibular bases; behind eyes sides rounding into highly convex occipital margin. Eyes relatively large, convex, in full face view clearly breaking lateral cephalic outline. Ocelli lacking, position of median ocellus marked by distinct pit; relative positions of lateral ocelli poorly indicated. Pronotum in dorsal view with humeri widely rounded; greatest pronotal width at mid-length of segment. Mesosoma in profile convex; promesonotal suture moderately strongly impressed; position of metanotal groove indicated by very weak impression; propodeum widely rounding into virtually vertical declivity. Petiole low, anterior, posterior and dorsal faces flat; dorsal spines reduced to minute denticles. Subpetiolar process rather long, acute anteriorly, obtusely angular posteriorly. Anterior face of first gastral segment in lateral view relatively low, widely rounded.

Mandibles finely, longitudinally rugose with numerous piliferous pits. Head, mesosoma and gaster rather smooth and polished, very finely, microscopically and uniformly shagreened with numerous very shallow punctures. Anterior face of petiole finely, transversely wrinkled.

Mandibles with numerous, relatively short, ereet to semiereet hairs. A few, medium length, anteriorly direeted setae medially on anterior elypeal margin, several shorter setae lining margin laterally. Rather short, paired, ereet hairs near anterior and basal elypeal margins and along frontal earinae; pair of longer, somewhat eurved hairs on summit of mesosoma. A few, isolated, long, ereet hairs anteriorly on fore eoxae and along ventral surfaces of trochanters and femora, hairs absent in some specimens. Medium length hairs along posterior margins of apieal gastral segments, hairs more abundant on gastral venter.

Colour. Black with mandibular mastieatory borders, eondylae and extreme tips of apieal funicular segments reddish-brown. Legs, including trochanters, red or reddish-brown with distal ends of femora very narrowly darker; proximal ends of tibiae and tarsi very dark brown or black.

Queen. Dimensions (paratype queen eited first): TL e. 8.32, 8.21; HL 1.87, 1.81; HW 1.59, 1.62; CI 85, 89; SL 2.37, 2.50; SI 149, 1.54; PW 1.72, 1.72; MTL 3.03, 3.15 (2 measured). Apart from sexual eharaeters, elosely resembling worker except: pronotal humeri widely rounded; mesoseutum slightly wider than long with lateral margins distinetly eonverging anteriorly, forming narrowly rounded anterior margin; median line weakly indieated, very short; parapsides rather flat; in profile mesoseutum with dorsum gently eurved anteriorly, rather flat posteriorly. Mesoseutellum eonvex, slightly elevated above dorsal plane of mesosoma; metanotal groove distinet, well impressed. Propodeal dorsum eonvex in profile, evenly rounded into vertieal deelivity. Very fine, mieroseopie seulpturation, rather sporadie dorsal pilosity and polished appearance as in worker.

Males and immature stages unknown.

REMARKS. *Polyrhachis damm* is a relatively eommon speeies at suitable, lowland rainforest localities. It is apparently endemie to Borneo and has been previously misidentified as *P. semiinermis*, a very similar speeies described by Donisthorpe from the Philippines. *Polyrhachis damm* also resembles *P. brevinoda* from north Queensland, deseribed above. Distinguishing eharaeters of all three speeies are diseussed in the remarks seetion for *P. brevinoda.*

Polyrhachis laevissima Fr. Smith, 1858
(Fig. 6G-H)

Polyrhachis laevissimus Fr. Smith, 1858: 64, pl. 4, fig. 42. Holotype worker. Type locality: MYANMAR (= Burma) (Waring), BMNH (examined).

Polyrhachis (Cyrtomyrma) laevissima Fr. Smith; Wheeler, 1919: 137; Emery, 1925: 207; Donisthorpe, 1938: 252, fig. 5.

REMARKS. *Polyrhachis laevissima* elosely resembles *P. sulang* deseribed below, but the latter differs in having a distinetly lower and more evenly eonvex mesosomal profile (ef Figs 7E, 6G). They also differ in the eonfiguration of the petiolar spines, with those in *P. laevissima* reduced to obtuse teeth, while the lateral teeth in *P. sulang* are distinetly elongate. The legs in *P. laevissima* are distinetly light red, while in *P. sulang* the legs are darker with black eoxae. *Polyrhachis laevissima* is distributed from Myanmar and India to Thailand, Malaysia, Sumatra and Java, with more reeent reeords from Borneo (Maliau Basin, Sabah).

Polyrhachis lepida sp. nov.
(Fig. 7A-B)

MATERIAL. HOLOTYPE: EAST MALAYSIA, SABAH, Kinabalu Park, Poring, 06°02'N, 116°43'E, e. 500m, 30.x.2000. rf edge, R.J. Kohout aee. 2000.181 (worker). PARATYPES: data as for holotype (11 workers). Type deposition: Holotype (QMT99344) and 2 paratypes in QM; 2 paratypes each ANIC, BMNH and MCZC; 1 paratype each AMNH, ITBC and NMNH. OTHER MATERIAL: EAST MALAYSIA, SABAH, Maliau Basin Cons. Area, Ginseng Camp, 04°44'S, 116°55'E, e.700m, 27.ii-11.iii.2005 (RJK & Effazilla Waty aee. 05.61) (w, ♀); ditto, Agathis Camp, 04°41'S, 116°54'E, e.500m, 16-19.iii.2005 (RJK & Lina Thomas aee. 05.84) (w); Kinabalu Park, Poring, 06°02'N, 116°43'E, >650m, 19.iii.1993 & 16.ii-7.iii.1997, fogging (A. Floren) (w); Sepilok Forest Reserve, 05°52'N, 117°56'E, 8.xi.2000 (RJK aee. 2000.209) (w); ditto, 27.viii.1995 (Sk. Yamane) (w); Crocker Ra. NP, Mahua Falls nr Tambunan, 05°47'N, 116°24'E, e. 950m, 4.xi.2000 (RJK aee. 2000.193) (w, ♂); Danum Valley Field Centre, 04°57'N, 117°48'E, e. 150m, 11-13.xi.2000 (RJK aees 2000.211, 237) (w, ♀); ditto, e. 150-240m, 24.ii-18.iii.1987, Malaise trap (C.v. Aehterberg) (w, ♀); ditto, xi.1995, fogging (E. Widodo) (w); nr Long Pa Sia (East), e.1000m, 1-13.iv.1987, Malaise trap (C.v. Aehterberg) (w, ♀); Forest Camp, 19km N of Kalabakan, e. 180m, 18.x.1962 (Y. Hirashima) (w); Forest Camp, 9.8km SW of Tenom, 18.xii.1962 (Y. Hirashima) (w). BRUNEI: Belait Distr., 1-2km SE of Melilas Longhouse, 16.vii.1994 (RJK aee. 94.120) (w, ♀); Ulu Belait, Kuala Ingai, 12-15.vii.1994 (RJK 94.114). INDONESIA, KALIMANTAN TIMUR, Bukit Soehart (UNMUL forest), 12.viii.1992 (Sk. Yamane) (w); Teluk Kabah Kutai N.P., 17.ix.1993 (Sk. Yamane) (w). KALIMANTAN SELATAN, 22km E of Banjarmasin, kerangas woodland, 25.vi.1972 (W.L. Brown) (w).

DESCRIPTION. *Worker.* Dimensions (holotype eited first): TL e. 5.90, 5.64-6.00; HL 1.47, 1.40-1.50; HW 1.34, 1.28-1.37; CI 91, 89-93; SL

1.78,1.68-1.81; SI 133, 128-136; PW 1.15, 1.09-1.18; MTL 2.03, 1.96-2.12 (12 measured).

Clypeus in profile almost straight anteriorly, posteriorly rounding into moderately impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate with weakly raised margins; central area weakly concave with poorly defined, short furrow. Sides of head in front of eyes very weakly convex, converging anteriorly; behind eyes rounding into convex occipital margin. Eyes in full face view clearly breaking lateral cephalic outline. Ocelli lacking; relative positions of lateral ocelli indicated by weak punctures in cephalic sculpture. Pronotum in dorsal view with greatest width across narrowly rounded or subangular humeri. Mesosoma in profile with pronotum convex anteriorly, mesonotum and propodeum weakly convex; promesonotal suture distinct; position of metanotal groove indicated by weak impression in lateral outline; propodeum unarmed or with rudimentary tubercles in some specimens; propodeal dorsum rounding rather abruptly into steep declivity. Petiole with anterior face almost straight, posterior face convex; dorsum armed with pair of short, broad-based dorsal teeth and pair of distinctly longer and slender lateral spines. Subpetiolar process acute anteriorly, obtusely angular posteriorly. Anterior face of first gastral segment in lateral view relatively low, straight, narrowly rounding onto dorsum of segment.

Mandible very finely, mostly longitudinally rugose with numerous piliferous pits. Dorsa of head, mesosoma and gaster finely and uniformly shagreened, rather polished, with numerous shallow punctures. Intensity of mesosomal sculpturation increasing laterally, becoming coarsely reticulate-rugose with meso- and metapleurae distinctly rugose. Petiole finely transversely wrinkled, more rugose around base.

Mandibles with several semierect and curved, short hairs, notably towards outer margins and masticatory borders. Single pair of relatively long, anteriorly directed setae medially on anterior clypeal margin, a few distinctly shorter setae lining margin laterally. Several pairs of relatively short hairs arising near anterior and basal clypeal margins, along frontal carinae and on vertex. Anterior face of fore coxae, trochanters and proximal ends of fore femora on ventral aspect with a few longer hairs. Gaster with relatively few erect hairs lining posterior margins of apical segments. Whole body with extremely short appressed hairs arising from numerous shallow punctures.

Colour. Black; mandibular teeth, condylae and extreme tips of apical funicular segments reddish-brown. Legs, including trochanters, light to medium reddish-brown with distal ends of femora and tibiae very narrowly, and proximal ends of tibiae widely, black. Coxae and tarsi black.

Queen. Dimensions: TL c. 6.80-7.61; HL 1.50-1.65; HW 1.40-1.56; CI 91-94; SL 1.78-1.93; SI 120-129; PW 1.43-1.72; MTL 2.18-2.43 (7 measured). Apart from sexual characters, very closely resembling worker except: pronotal humeri rounded; mesoscutum wider than long with lateral margins converging anteriorly, anterior margin narrowly rounded; median line weakly indicated, short; parapsides rather flat; mesoscutellum in profile weakly convex, only marginally elevated above dorsum of mesosoma; metanotal groove distinct; propodeum in some specimens with indistinct, rudimentary tubercles; propodeal dorsum convex or almost straight in profile, descending into oblique declivity in rather blunt angle.

Males deposited in the QM collection. Immature stages unknown.

REMARKS. *Polyrhachis lepida* is apparently endemic to Borneo and distributed throughout the island. It is a relatively common species along the edges of rainforest clearings from the lowlands to higher altitudes. They usually build nests between leaves in the lower arboreal zone. However, one nest was located in a hollow internode of a dry bamboo stem lying on the ground. *Polyrhachis lepida* is somewhat similar to *P. rastellata*, but can be distinguished by its generally smaller size, distinctly more convex occiput and longer antennal scapes (SI 128-136 versus 111-123 in *P. rastellata*). They also differ in the configuration of the petiolar spines with the lateral pair in *P. lepida* distinctly longer than the dorsal pair. In contrast, the petiolar spines in *P. rastellata* are subequal or the lateral pair is somewhat shorter than the dorsal pair. The two species also differ in the colour of their legs with those of *P. lepida* consistently darker.

Polyrhachis rastellata (Latreille, 1802) (Fig. 7C-D)

Formica rastellata Latreille, 1802: 130. Holotype queen. Type locality: 'INDES ORIENTALES' (type apparently lost).
Polyrhachis rastellata (Latreille). Fr Smith, 1858: 59.
Polyrhachis (Cyrtomyrma) rastellata (Latreille). Forel, 1915: 107; Donisthorpe, 1938: 254.

REMARKS. The holotype queen of *P. rastellata* was apparently lost "a long time ago" (J. Casevitz Weulersse, MNHN, *pers. comm.*) and during the

past two centuries more than twenty infraspecific names have been connected to this name. My current interpretation of this species is based upon specimens from India that Donisthorpe considered to be *P. rastellata* ['Described from an Indian specimen (*Wroughton*)' (Donisthorpe, 1938)]. However, the type locality of *P. rastellata* is the 'Indes orientales' or the East Indies, and probably corresponds to modern day Malaysia and Indonesia. Consequently, interpreting *P. rastellata* based on Indian material may well be incorrect. It would be highly desirable to establish the nomenclatural stability of this species by the designation of a neotype. However, I believe that such an action would not be appropriate here, as I have not attempted a revision of the Asian fauna of the subgenus.

In the literature, *P. rastellata* has been reported to occur over most of south-east Asia and south across Indonesia and New Guinea to northern Australia. However, many of these records are linked to the numerous infraspecies connected to that name. Several authors, including Mayr (1872: 138) and Wheeler (1919: 136) listed *P. rastellata* from Borneo and various authors have listed it from New Guinea. Consequently, I have included it in the lists and keys of species from both regions. However, I have not seen any Bornean or New Guinean material satisfactorily comparable with the specimens from India that Donisthorpe considered to be *P. rastellata* and I believe that the nominal form is restricted to India, Sri Lanka, Myanmar and former Indochina, including Sumatra and possibly Java.

Polyrhachis rastellata resembles *P. lepida*, described above, with their main distinguishing characters listed under the latter.

Polyrhachis sulang sp. nov.
(Fig. 7E-F)

MATERIAL. HOLOTYPE: BRUNEI, Tutong Distr., Bukit Sulang nr Lamunin, 20.viii.-10.ix.1982, fogging, N.E. Stork (B.M.1982-388) (worker). PARATYPE: data as for holotype (1 worker). Type deposition: Holotype in BMNH, paratype in QM.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 5.44, 5.85; HL 1.43, 1.50; HW 1.40, 1.47; CI 98, 98; SL 1.56, 1.62; SI 111, 110; PW 1.15, 1.22; MTL 1.93, 1.96 (2 measured).

Clypeus in profile evenly convex; basal margin only very weakly impressed medially. Frontal triangle shallowly impressed. Frontal carinae sinuate with very weakly raised margins; carinae widely separated, central area relatively broad and flat, with distinct frontal furrow. Sides of head in front of eyes weakly convex, converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes weakly convex, in full face view not or only just reaching lateral cephalic outline. Ocelli lacking, relative position of median ocellus indicated by very shallow depression in sculpture. Pronotum in dorsal view with humeri produced anterolaterally into strong, triangular teeth. Mesosoma in profile convex anteriorly; promesonotal suture distinct; mesonotum and propodeum weakly convex; metanotal groove indistinct dorsally, laterally consisting of a short furrow above spiracle. Propodeum unarmed, declivity rather short, oblique. Petiole with anterior face weakly convex, posterior face distinctly convex; dorsum armed with pair of broad-based dorsal teeth and pair of longer, acute lateral spines. Subpetiolar process widely rounded posteriorly. Anterior face of first gastral segment very weakly concave, narrowly rounding onto dorsum of segment.

Mandibles finely, mostly longitudinally rugose with numerous piliferous pits. Head, mesosoma, petiole and gaster finely shagreened, rather polished. Sculpturation only marginally increasing in density laterally with sides of pronotum, meso- and metapleurae and petiole weakly reticulate. Numerous shallow punctures and piliferous pits scattered over all dorsal surfaces.

Mandibles with numerous curved and semierect, short hairs on masticatory borders and outer margins. Anterior clypeal margin fringed with a few, anteriorly directed, relatively short setae, distinctly reducing in length laterally. Somewhat longer, paired hairs arising near anterior and basal clypeal margins and along frontal carinae. A few very short, bristle-like hairs lining apices of antennal scapes; a few isolated, medium length hairs on anterior face of fore coxae. Apex of gaster with medium length, erect hairs along posterior margins of segments.

Colour. Black; mandibular teeth, condylae and extreme tip of apical funicular segments reddish-brown. Legs, including coxae of mid- and hind legs, rather dark reddish-brown, fore coxae, bases of trochanters, proximal ends of tibiae and tarsi black.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis sulang* is known only from the type locality. Nothing is known about its nesting habits, but both specimens were collected by fogging and it is reasonable to suggest that they build their nests high in the

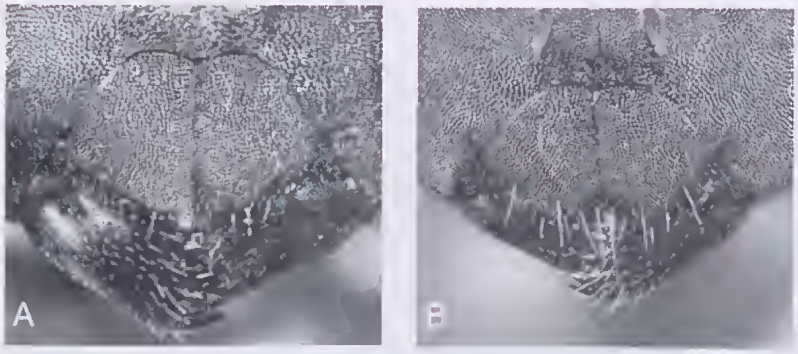


FIG. 5. *Polyrhachis (Cyrtomyrma)* species from Borneo. Frontal view of clypeus. A, *P. achterbergi* sp. nov.; B, *P. widodoi* sp. nov.

rainforest canopy. *Polyrhachis sulang* closely resembles *P. laevissima* Fr. Smith and *P. gibba* Emery from Sulawesi but differs from both by the distinctly lower and more evenly rounded outline of its mesosoma. It also differs from *P. laevissima* by the configuration of the petiolar spines. In *P. laevissima* they are reduced to obtuse teeth, while in *P. sulang* the lateral petiolar spines are distinctly elongate. From *P. gibba* it differs by its considerably smaller size (HL 1.43-1.50 in *P. sulang* versus 1.68-1.78 in *P. gibba*) and by the sculpturation of the body which, in *P. gibba* is rather coarse, notably on the head and sides of the mesosoma. The sculpturation in *P. sulang* is much finer, with the head and mesosoma only superficially sculptured and highly polished. The legs, including the coxae, are distinctly light to medium red in *P. laevissima*, reddish-brown with black coxae in *P. sulang* and all virtually black in *P. gibba*.

Polyrhachis widodoi sp. nov.
(Fig. 5B)

MATERIAL. HOLOTYPE: EAST MALAYSIA, SABAH, Gunung Rara, Tawau, 200-300m, 27.ii.1996, primary rf., canopy fogging, Erwin Widodo (worker). PARATYPE: Danum Valley Conserv. Area, Segama River trail, 04°57'N, 117°48'E, c. 150m, 11.xi.2000, rf., R.J. Kohout acc. 2000.217 (worker). Type distribution: Holotype in ITBC; paratype in QM.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.85, 7.11; HL 1.93, 2.00; HW 2.12, 2.03; CI 110, 101; SL 1.87, 1.96; SI 88, 96; PW 1.50, 1.47; MTL 2.37, 2.43 (2 measured).

Head broad, distinctly wider than long. Anterior clypeal margin with rather deep, open 'V' shaped emargination, laterally flanked by distinct teeth. Clypeus in profile virtually straight medially, smoothly curving posteriorly into shallow basal margin; flat median line, clearly interrupting clypeal sculpturation, running posteriorly from centre of emargination to base of weakly impressed frontal triangle. Frontal carinae short with very weakly raised margins; central area with distinct, rather shallow frontal furrow. Sides of head almost straight in front of eyes; behind eyes widely rounding into weakly medially concave occipital margin. Lateral carina separating gena from ventral parts of head absent. Eyes rather flat, situated well forward and inward from occipital corners; in full face eyes not reaching lateral cephalic outline. Ocelli indistinct in holotype, in paratype relative positions indicated by indistinct, shallow punctures in sculpture. Mesosoma in lateral view similar to that in *P. achterbergi*, but distinctly lower and less strongly convex, more closely resembling that of *P. bruehli*. In dorsal view pronotal humeri less massive than in *P. achterbergi* with pronotum narrower and spines somewhat more slender and acute. Promesonotal suture distinct, metanotal groove weakly indicated by shallow depression. Petiole armed with four spines; lateral spines longer than dorsal pair, but distinctly shorter than those in *P. achterbergi*.

Sculpturation of head, mesosoma and gaster consisting of uniform reticulate puncturation, identical to that in *P. achterbergi* and *P. bruehli*. Gaster very finely shagreened.

Pilosity, pubescence and colour as in *P. achterbergi*.

REMARKS. *Polyrhachis widodoi* is very similar to *P. achterbergi* with many characters virtually identical in both species. However, *P. widodoi* differs in several features, including the shape of the anterior clypeal margin. The margin in *P. widodoi* is deeply and widely emarginate medially with the emargination laterally flanked by distinct teeth (Fig. 5B). In contrast the anterior clypeal margin in *P. achterbergi* is has a central, anteriorly projecting, blunt tooth (Fig. 5A). Additionally, the mesosoma in *P. widodoi* is distinctly flatter in lateral view and the lateral petiolar spines shorter than those in *P. achterbergi*.

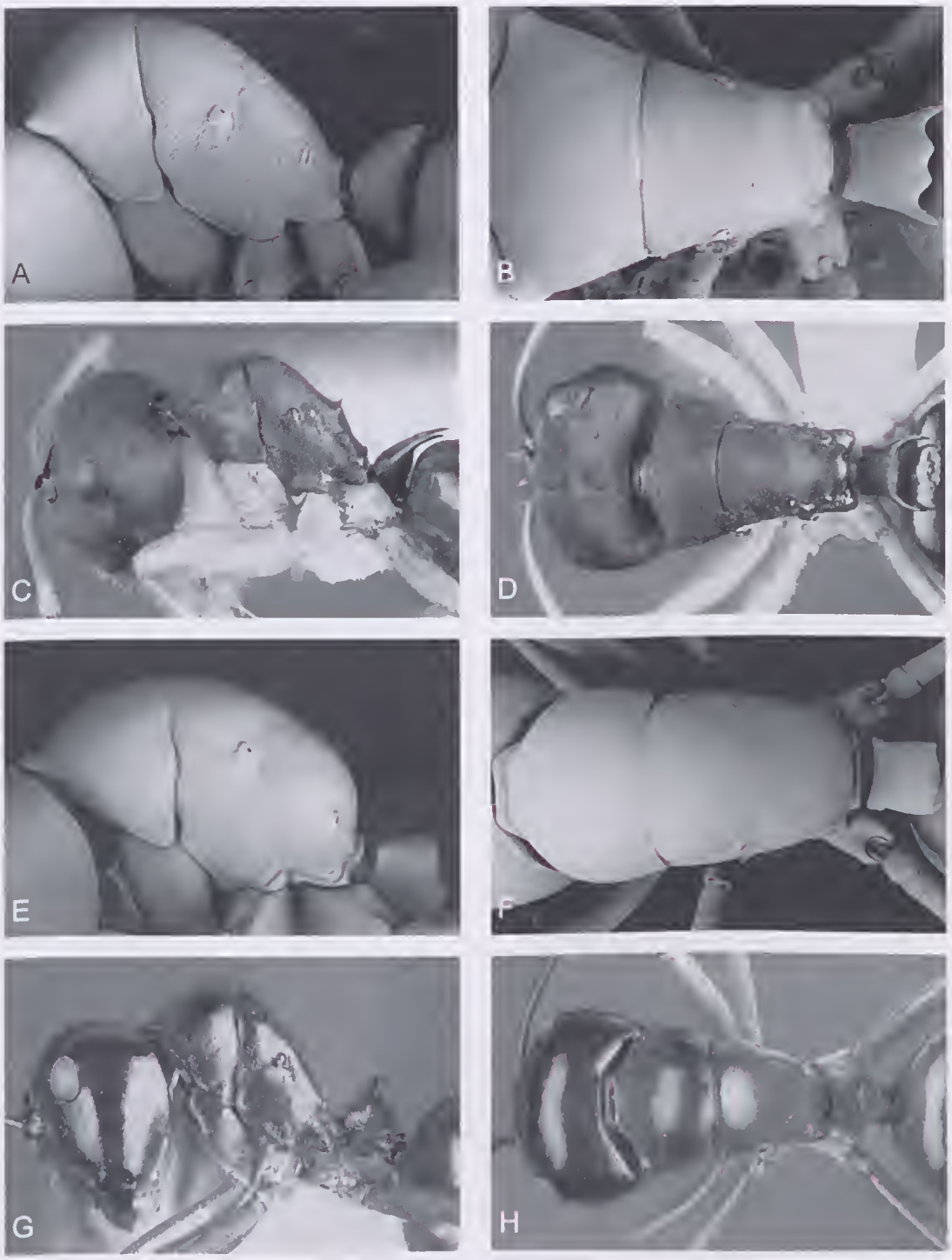


FIG. 6. *Polyrhachis (Cyrtomyrma)* species from Borneo, Lateral view of mesosoma and petiole (left); dorsal view of mesosoma and petiole (right). A-B, *P. achterbergi* sp. nov.; C-D, *P. bruehli* sp. nov.; E-F, *P. danum* sp. nov.; G-H, *P. laevissima* Fr. Smith.

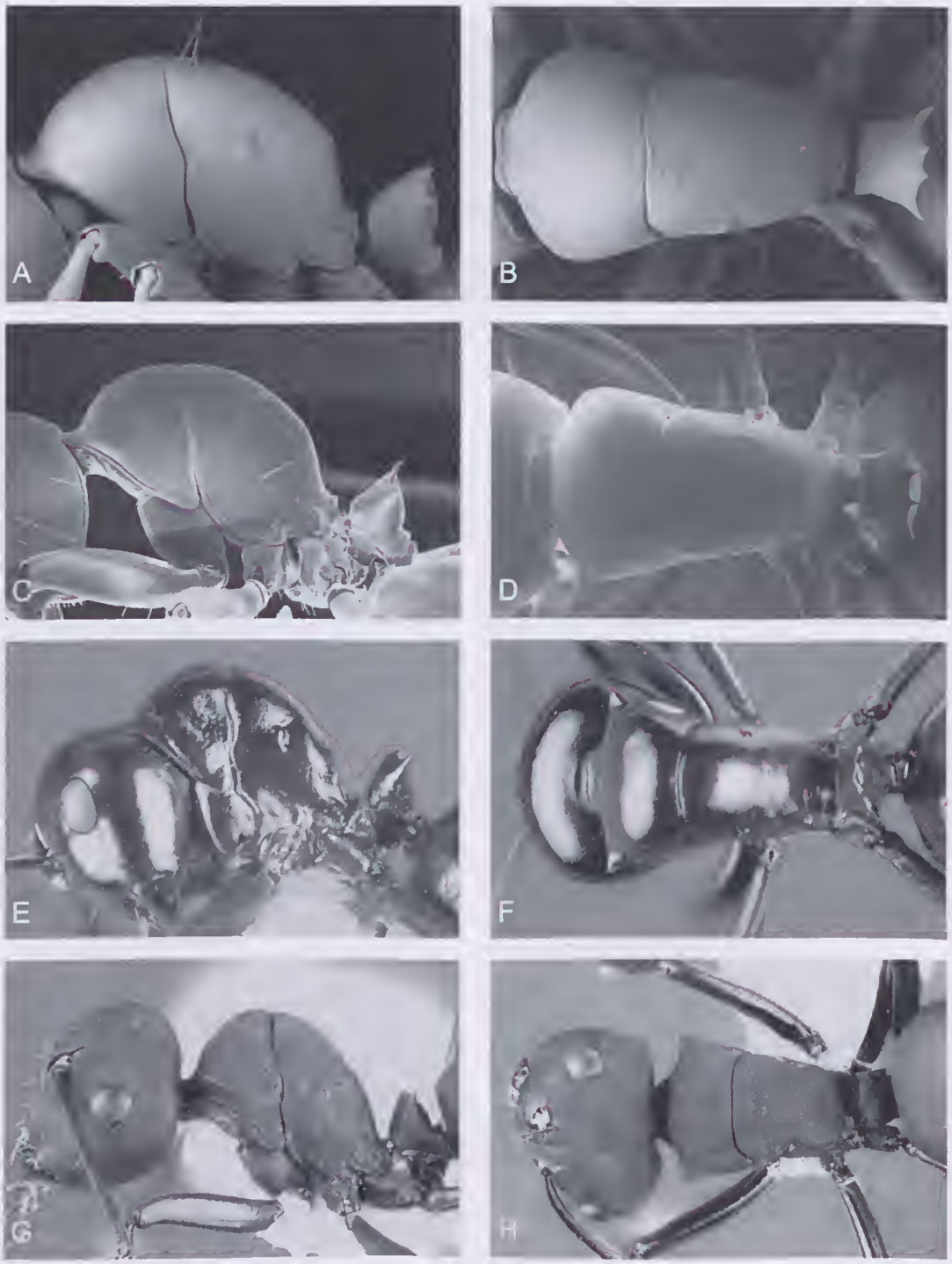


FIG. 7. *Polyrhachis (Cyrtomyrma)* species, Lateral view of mesosoma and petiole (left); dorsal view of mesosoma and petiole (right). A-B, *P. lepida* sp. nov.; C-D, *P. rastellata* (Latreille); E-F, *P. sulang* sp. nov.; G-H, *P. vitalisi* Fr. Smith.

CHECKLIST OF *CYRTOMYRMA* SPECIES FROM NEW GUINEA

The following list includes all *Cyrtomyrma* species known to occur in New Guinea, the Bismarck Archipelago and on neighbouring islands. *Polyrhaehis brevinoda* and *P. decumbens* mainly occur in australia but their distributions just extend into New Guinea. They are treated wih the Austrlian species. It also includes *P. rastellata* (in parentheses in the list and key) that has been previously reported from New Guinea. However its occurrence there is unconfirmed and unlikely (see discussion under the Bornean species). Synonyms are indented with extralimital junior synonyms excluded.

P. albertisi Emery
P. aporema sp. nov.
P. barryi sp. nov.
P. brevinoda sp. nov.
P. conspicua sp. nov.
P. debilis Emery
P. decumbens sp. nov.
P. dorsena sp. nov.
P. euryala Fr. Smith
    P. rastellata torricelliana Viehmeyer
P. hybosa sp. nov.
P. indueta sp. nov.
P. inflata sp. nov.
P. integra sp. nov.
P. kyawthani sp. nov.
P. leonidas Forel
P. linae Donisthorpe
P. luctuosa Emery
P. mondoi Donisthorpe
P. nomo Donisthorpe
P. ralumensis Forel
    P. rastellata major Stitz
(*P. rastellata* (Latreille))
P. sedlaceki sp. nov.
P. strumosa sp. nov.
P. tuberosa sp. nov.
P. wagneri Viehmeyer

The following key represents only a rough guide to the New Guincan *Cyrtomyrma* species. Besides the newly described species, it includes all the clearly taxonomically defined New Guincan taxa, as well as three closely related species occuring on neighbouring Indonesian islands. These three species (*P. aruensis* and *P. levior* from the Aru Islands and *P. goramensis* from Seram) are discussed with the New Guinean species below for comparison. The key excludes some subspecific taxa of unresolved status and a taxonomically difficult group of species treated collectively and identified as '*rastellata*' by several authors. New Guinea has undoubtedly the most diverse *Cyrtomyrma* fauna and many more new species are likely to occur there. A taxonomic revision of the New Guinean *Cyrtomyrma* is presently under consideration, however, more detailed study of the material available, notably that in the collections of the Museum of Comparative Zoology, Cambridge and Bernice P. Bishop Museum, Honolulu, would be neccessary before it could be successfully attempted.

KEY TO *CYRTOMYRMA* SPECIES FROM NEW GUINEA (BASED ON WORKER CASTE)

1. Pronotal humeri in dorsal view toothed, obtusely angular, or narrowly rounded; greatest width of pronotal dorsum across, or just behind shoulders (e.g. Figs 7D, 11F) ... 2

    Pronotal humeri in dorsal view widely rounded; greatest width of pronotal dorsum at about mid-length of segment (e.g. Figs 8H, 9D) ... 10

2. Propodeum armed with a pair of more-or-less distinct spines (Fig. 8C) ... 3

    Propodeum totally unarmed (Figs 7C, 11E) ... 7

3. Pronotal humeri bilobed or produced into prominent teeth ... 4

    Pronotal shoulders angular or narrowly rounded ... 5

4. Propodeal spines long, dorso-ventrally compressed, widely diverging and bluntly terminated (Aru Is) ... *levior* Roger

    Propodeal spines very short, upturned and acute ... *albertisi* Emery

5. Propodeal spines long, dorsoventrally compressed, widely diverging and bluntly terminated; lateral petiolar spines distinctly longer than dorsal pair (Fig. 8C-D) ... *barryi* sp. nov. (in part)

    Propodeal spines short, acute, strongly upturned ... 6

6. Larger species (HL >1.68) ... *linae* Donisthorpe

    Smaller species (HL 1.56) ... *mondoi* Donisthorpe

7. Pronotal shoulders produced into prominent teeth (Aru Is) ... *aruensis* Viehmeyer

    Pronotal shouders angular or narrowly rounded (Figs 7D, 11F) ... 8.

8. Larger species (HL 2.09); head very broad with eyes rather flat, in full face view not reaching lateral cephalic outline (Bismarck Archipelago) ... *ralumensis* Forel

    Smaller species (HL <1.76); eyes convex, in full face view clearly extending beyond lateral cephalic outline ... 9

9. Pronotal dorsum with anterior face distinctly convex in profile (Fig. 7C); propodeal declivity oblique; legs orange or light red ..... (*rastellata* (Latreille))

Pronotal dorsum with anterior face almost straight in profile (Fig. 11E); propodeal declivity virtually vertical; legs very dark reddish-brown ..... *strumosa* sp. nov.

10. Propodeum armed with a pair of more-or-less distinct spines or tubercles (Figs 8C, 9A, 9E, 10A) 11

Propodeum totally unarmed (eg. Figs 9G, 10C, 10G, 11A) 17

11. Pronotal dorsum in profile elevated, distinctly convex (Figs 9A, 10A) 12

Pronotal dorsum only weakly convex or flat (Figs 8C, 9E) 13

12. Lateral petiolar spines distinctly elongated; summit of pronotal dorsum only marginally higher than dorsum of mesonotum (Fig. 9A) (Seram I.) ... *goramensis* Emery

Lateral petiolar spines very short, rudimentary; summit of pronotal dorsum distinctly higher than dorsum of mesonotum (Fig. 10A) ..... *integra* sp. nov.

13. Larger species (HL >1.55) 14

Smaller species (HL <1.50) 16

14. Propodeal spines well developed, dorso-ventrally compressed (Fig. 8C); pronotal humeri rounded, weakly subangular (Fig. 8D) 15

Propodeal spines rudimentary or present only as distinct tuberculae; pronotal humeri evenly rounded; petiole strongly transverse with dorsal spines reduced to minute denticles, lateral spines slender, widely diverging ..... *wagneri* Viehmeyer

15. Petiole with spines more-or-less subequal; propodeal spines short, strongly upturned (Bismarck Archipelago) ..... *leonidas* Forel

Petiole with lateral spines distinctly longer than dorsal spines; propodeal spines long, only weakly upturned (Fig. 8C-D) ..... *barryi* sp. nov. (in part)

16. Body covered with abundant appressed and decumbent hair; propodeal spines short, upturned; lateral petiolar spines long, slender (Fig. 9E-F) .... *inducta* sp. nov.

Body with only sparse appressed hair; propodeal spines very short or present as mere denticles or tuberculae; petiolar spines subequal ..... *debilis* Emery

17. Petiole virtually parallel-sided; petiolar spines very short, rudimentary (Fig. 1G) ..... *brevinoda* sp. nov.

Petiole with sides dorsally diverging; petiolar spines of various configurtions, well developed (e.g. Figs 8B, 10H) 18

18. Head, mesosoma and petiole distinctly, closely reticulate-punctate, opaque (Figs 9G, 10E) 19

Head, mesosoma, petiole and gaster very finely shagreened, rather smooth (eg Figs 8E, 11A) 20

19. Pronotal dorsum distinctly swollen, exceptionally high (Fig. 9G), with medially impressed longitudinal furrow along summit (Fig. 9H) ..... *inflata* sp. nov.

Pronotal dorsum not distinctly swollen (Fig. 10E), without longitudinal furrow on summit (Fig. 10F) *luctuosa* Emery

20. Petiole with pair of long, slender, outward- and backward-directed lateral spines, dorsal pair reduced to minute denticles (Fig. 11B); body surfaces smooth and highly polished (Fig. 11A) ..... *sedlaceki* sp. nov.

Petiole with lateral spines only marginally longer than dorsal pair or all spines subequal in length (eg. Figs 10D, 11H) 20

21. Body with numerous appressed and decumbent hairs (Fig. 10G) ..... *nomo* Donisthorpe

Body with only very sparse, short appressed hairs . 22

22. Larger species (HL>1.47); lateral petiolar spines distinctly longer than dorsal pair; boy pubescence rather diluted (Fig. 10G, H) (New Guinea). ..... *nomo* Donisthorpe

Smaller species (HL<1.40); petiolar spines subequal; body pubescence abundant (Figs 11I, J) (Australia, Papua) ..... *decumbens* sp. nov.

23. Mesosomal dorsum in profile with evenly convex outline ..... *euryala* Fr. Smith

Mesosomal dorsum in profile with distinctly uneven outline (eg. Figs 8A, 8E, 8G, 11G) 24

24. Propodeal declivity oblique (Figs 8E, 8G, 11G) ... 25

Propodeal declivity virtually vertical (Figs 8A, 9C, 10C) 27

25. Pronotal dorsum exceptionally high (Fig. 8E), with short, medially impressed longitudinal furrow (Fig. 8F) ..... *conspicua* sp. nov.

Pronotal dorsum not exceptionally high (Figs 8G, 11G), longitudinal furrow lacking (Figs 8H, 11H) 26

26. Anterior face of pronotal dorsum ascending towards rather short summit in very weakly convex, almost straight line (Fig. 11G) ..... *tuberosa* sp. nov.

Anterior face of pronotal dorsum ascending in strongly convex line towards distinctly swollen dorsum; pronotal-mesonotal summit relatively long (Fig. 8G) ..... *dorsena* sp. nov.

27. Mesosoma in outline with pronotal dorsum strongly convex, rather swollen; propodeum relatively low (Fig. 9C) ..... *lyrbosa* sp. nov.

Mesosoma in outline with only weakly convex, rather low pronotal dorsum and distinctly high propodeum (Figs 8A, 10C) (Bismarck Archipelago) 28

28. Eyes distinctly convex, clearly breaking lateral cephalic outline in full face view; propodeal declivity lower, weakly concave at base; petiole with anterior face almost straight and posterior face convex (Fig. 8A) ... *aporema* sp. nov.

Eyes rather flat, situated well inside cephalic outline in full face view; propodeal declivity higher, virtually vertical; petiole distinctly biconvex (Fig. 10C) ..... *kyawthani* sp. nov.

Polyrhachis albertisi Emery, 1887

Polyrhachis albertisi Emery, 1887: 240. Syntype workers, queen. Type locality: NEW GUINEA, Sorong (L.M. D'Albertis), MCSN (examined).

Polyrhachis (Cyrtomyrma) albertisi Emery. Emery, 1925: 207; Donisthorpe, 1938: 250.

REMARKS. *Polyrhachis albertisi* is apparently a rare species endemic to New Guinea and the syntypes are the only specimens available. It is characterised by distinctly toothed or bilobed pronotal humeri and closely resembles *P. levior*, with the mesosomal structure similar in both species. However, the humeral prominences are nearly equal in *P. levior*, while in *P. albertisi* the anterior lobe forms a blunt, but distinct tooth (similar to that in *P. armensis* Viehmeyer) and the posterior lobe is only weakly defined. The propodeal spines in *P. albertisi* are short and strongly upturned, while in *P. levior* they are longer, more massive and somewhat dorsoventrally compressed.

Polyrhachis aporema sp. nov.
(Fig. 8A-B)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, East New Britain Prov., Gazelle Pen., Baining Mts, 3km N of Malasait, 04°26'S, 151°53'E, c. 600m, 11.vii.1984, R.J. Kohout acc. 84.23 (worker). PARATYPES: data (and nest) as for holotype (19 workers, alate ♀, 3 ♂♂). Type deposition: Holotype, 5 paratype workers, paratype ♀ and paratype ♂♂ in ANIC; 2 paratype workers each in BMNH, MCZC, BPBM and QM. OTHER MATERIAL: PAPUA NEW GUINEA, East New Britain Prov., Gazelle Pen., Warongoi Valley, 100m, 25.v.1956 (JLG) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.60, 6.35-7.15; HL 1.62, 1.56-1.68; HW 1.56, 1.45-1.59; CI 96, 93-98; SL 2.25, 2.12-2.25; SI 144, 138-146; PW 1.28, 1.18-1.33; MTL 2.71, 2.56-2.74 (11 measured).

Clypeus in profile weakly convex, posteriorly rounding into weakly impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate with weakly raised margins; central area weakly convex with frontal furrow distinct for most of its length. Sides of head in front of eyes weakly convex, converging towards mandibular bases; behind eyes sides rounding into broadly convex occipital margin. Eyes convex, in full face view clearly breaking lateral cephalic outline. Ocelli lacking, relative positions indicated by shallow punctures in cephalic sculpture. Pronotum in dorsal view with sides widely rounded, humeri indicated by weak angles in some specimens. Mesosoma in lateral view with pronotum very weakly convex, almost flat; promesonotal suture distinct, rather flat in outline; mesonotal dorsum weakly convex; metanotal groove indicated by very shallow impression; propodeal dorsum widely rounding into rather low, vertical declivity, weakly concave at base. Petiole in profile with anterior face straight, posterior face convex; dorsum armed with four, acute, subequal teeth, tips of dorsal pair distinctly bent backwards. Subpetiolar process acute anteriorly, widely rounded posteriorly. Anterior face of first gastral segment marginally lower than apices of dorsal petiolar spines.

Mandibles finely rugose with sculpture reducing in intensity towards bases; numerous piliferous pits in loose longitudinal rows. Head, mesosoma and gaster finely shagreened dorsally, intensity of sculpturation increasing laterally, becoming reticulate; meso- and metapleurae reticulate-rugose. Petiole finely reticulate dorsally; distinctly reticulate-rugose at base. Shallow punctures and piliferous pits scattered in various densities over most body surfaces, rather diluted along summit of mesosomal dorsum.

Mandibles with medium length, curved hairs fringing masticatory borders. Anterior clypeal margin with usually one or two long, anteriorly directed setae medially and several shorter setae laterally. Paired, medium length, erect or semierect hairs near anterior and basal clypeal margins and fringing frontal carinae; single pair of hairs on vertex; single pair of long hairs on summit of mesonotum. Pair of relatively long, erect hairs on anterior face of front coxae and several shorter, erect hairs ventrally on trochanters and femora. Gaster with numerous, erect, relatively long hairs lining posterior margins of segments with hairs on ventral surfaces more abundant.

Colour. Black, mandibular teeth, condylae, distal ends of antennal scapes, tip of apical funicular segments and legs medium reddish-brown. Funiculi, proximal ends of tibiae and tarsi dark brown.

Queen. Dimensions: TL c. 7.41; HL 1.68; HW 1.53; CI 91; SL 2.21; SI 144; PW 1.62; MTL 2.74 (1 measured). Apart from sexual characters, very similar to worker except: pronotal humeri widely rounded; mesoscutum wider than long with lateral margins converging anteriorly, forming widely rounded anterior margin; median line bifurcate posteriorly; parapsides rather flat, slightly raised posteriorly; mesoscutum in profile widely rounded anteriorly, dorsum very weakly convex. Mesoscutellum convex, marginally elevated above plane of mesosoma; metanotal groove distinct. Propodeal dorsum rather flat before descending into very steep, almost vertical declivity; pair of distinct, subacute, propodeal tubercules. Other characters, including sporadic pilosity and fine sculpturation, as in worker.

Males and immature stages (eggs, larvae and pupae) present in ANIC spirit collection.

REMARKS. *Polyrhachis aporema* is apparently restricted to the island of New Britain. The type colony consisted of a silk nest between leaves on a low tree in rainforest. *Polyrhachis aporema* is very similar to *P. kyawthani*, described below, with which it shares a similar mesosomal profile with a widely rounded propodeum and very steep declivity. However, *P. aporema* differs from *P. kyawthani* in the distinctly convex eyes that clearly break the lateral cephalic outline in full face view. The eyes in *P. kyawthani* are rather flat and situated well inside the cephalic outline. Although similar, the propodeal declivity in *P. aporema* is distinctly lower and weakly concave at the base, while in *P. kyawthani* the declivity is higher and virtually vertical. The petiole in *P. aporema* features a straight anterior face and convex posterior face, while the petiole in *P. kyawthani* is lower and distinctly biconvex.

Polyrhachis aruensis
Viehmeyer, 1912 stat. nov.

Polyrhachis laevissima var. *aruensis* Viehmeyer, 1912: 9. Syntype workers. Type locality: INDONESIA, Aru Is., Wammar, Dobo (C. Ribbe), MNHU (examined).

Polyrhachis (Cyrtomyrma) laevissima var. *aruensis* Viehmeyer. Emery, 1925: 207; Donisthorpe, 1938: 253.

REMARKS. *Polyrhachis aruensis* differs from *P. laevissima* in having the mesosomal dorsum evenly convex in profile. The petiolar spines are very distinct, slender and acute and the subpetiolar process bluntly angular posteriorly. In contrast the profile of the mesosomal dorsum in *P. laevissima* (Fig 6G-H) features a rather convex pronotum, with the mesonotum, propodeum and declivity descending posteriorly in a very weakly bowed line. The petiolar spines are rather short and blunt and the subpetiolar process is very weakly rounded posteriorly. *Polyrhachis aruensis* is apparently a rare species, endemic to the Indonesian Aru Islands. Specimens collected by W. Karawajew (Wokan and Wammar Is) are the only material of the species known, apart from the syntypes.

Polyrhachis barryi sp. nov.
(Fig. 8C-D)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, Morobe Prov., Huon Pen., Mongi Watershed, Gemeheng, 1300m, 11-13.iv.1955, E.O. Wilson #788 (worker). PARATYPES: data as for holotype (2 workers); ditto, Mongi Watershed, Tumnang, 1500m, 14-15.iv.1955, E.O. Wilson #805 (3 workers). Type deposition: Holotype and 2 paratype workers in MCZC; paratype worker each in ANIC, BMNH and QM. OTHER MATERIAL: PAPUA NEW GUINEA, Eastern Highlands Prov., Kassam, 48km E of Kainantu, 1350m, 28.x.1959, T.C. Maa (worker); Morobe Prov., Bulolo, 3000-4000ft, 21.xii.1970, B.B. Lowery (w, ♀).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.25, 5.80-6.25; HL 1.62, 1.55-1.62; HW 1.53, 1.37-1.53; CI 94, 89-96; SL 2.06, 1.81-2.06; SI 135, 125-135; PW 1.31, 1.18-1.31; MTL 2.43, 2.18-2.43 (6 measured).

Clypeus in profile straight anteriorly, posteriorly rounding into medially impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate with weakly raised margins; central area weakly concave with indistinct frontal furrow. Sides of head in front of eyes moderately convex, converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes convex, rather large and prominent, in full face view clearly breaking lateral cephalic outline. Ocelli lacking. Pronotum in dorsal view with humeri rounded or very weakly angular; greatest width of pronotal dorsum behind shoulders or towards mid-length of segment in some specimens. Mesosoma in profile relatively low, convex anteriorly, weakly sinuate posteriorly; promesonotal suture distinct; mesonotal dorsum weakly convex; metanotal groove lacking; propodeum armed with relatively long, blunt, widely diverging and distinctly dorso-ventrally compressed spines; posterior margins of spines continued medially, forming wide 'U' but failing to meet, leaving a small gap through which propodeal dorsum meets rather steep declivity. Petiole with anterior face straight, posterior face weakly convex; dorsum armed with four spines; dorsal pair short, broad-based with tips slightly bent backwards; lateral pair slender, more than twice as long as dorsal pair. Subpetiolar process acutely angular anteriorly, narrowly rounded posteriorly. Anterior face of first gastral segment flat, rounding in even curve onto dorsum of segment.

Mandibles very finely, mostly longitudinally rugose with numerous shallow pits. Head, mesosoma and gaster shagreened with sides of pronotum, meso- and metapleurae and lower portions of petiole distinctly reticulate to reticulate-rugose. Shallow, mostly piliferous punctures rather densely distributed over all body surfaces.

A few semierect hairs at mandibular masticatory borders. Anterior clypeal margin lined with relatively short, anteriorly directed setae. Several

paired, medium length, erect hairs near anterior and basal clypeal margins and along frontal carinae. A few rather long, erect hairs on anterior face of fore coxae; medium length, erect hairs on anterior face of subpetiolar process and around apical gastral segments. Numerous very short, appressed hairs arising from punctures over most body surfaces.

Colour. Black; including most of antennal scapes, coxae and tarsi. Mandibular masticatory borders, condylae and extreme tip of apical funicular segments light to medium reddish-brown. Legs varying from light reddish-brown, with proximal ends of tibiae narrowly darker, to very dark brown.

Queen. Dimensions: TL c. 7.46; HL 1.78; HW 1.68; CI 94; SL 2.18; SI 130; PW 1.75; MTL 2.87 (1 measured). Apart from sexual characters, very similar to worker except: pronotal humeri more rounded, mesoscutum slightly transverse, with evenly rounded anterior margin; median line short, not reaching dorsum of segment; parapsides rather flat, slightly elevated posteriorly; dorsum of mesoscutum in profile flat posteriorly, widely rounded anteriorly. Mesoscutellum convex, elevated above dorsal plane of mesosoma. Metanotal groove distinct. Propodeal dorsum weakly convex, abruptly rounding into vertical declivity; propodeal spines slightly shorter than in worker. Petiole with pair of short, very broad-based dorsal teeth and pair of more slender, distinctly longer lateral spines. Other characters, including sculpturation and virtual lack of dorsal pubescence as in worker.

Males and immature stages unknown.

REMARKS. *Polyrhachis barryi* is apparently restricted to higher elevations in Papua New Guinea. Nothing is known about its nesting habits, but a tag on specimens collected by B.B. Lowery states they were collected 'under bark and on foliage of Hoop pine in plantation'. *Polyrhachis barryi* is relatively similar to *P. leonidas* Forel from the Bismarck Archipelago from which it can be distinguished by its distinctly finer body sculpturation, a more convex pronotal dorsum and distinctly longer propodeal and lateral petiolar spines. *Polyrhachis leonidas* has short to very short, strongly upturned, almost vertical propodeal spines and petiolar spines that are subequal in length. The eyes also differ with those of *P. leonidas* being more convex and prominent, clearly breaking lateral cephalic outline in full face view.

Polyrhachis conspicua sp. nov.
(Fig. 8E-F)

MATERIAL. HOLOTYPE: INDONESIA, WEST IRIAN, Waris, S of Hollandia (= Sukarnaputra), 03°30'S, 140°55'E, 450-500m, 24-31.viii.1959, T.C. Maa (worker). PARATYPES: data as for holotype (1 worker); INDONESIA, WEST IRIAN, Nabire, S of Geelving Bay, 03°22'S, 135°29'E, 1-20m, 3.vii.1962, J.L. Gressitt & J. Sedláček (worker); INDONESIA, Schouten Is, SE Biak I., 01°00'S, 136°00'E, 1.vii.1962, J.L. Gressitt & J. Sedláček (2 workers). PAPUA NEW GUINEA, West Sepik Prov., Pes Mission, c.12km WSW of Aitape, 03°11'S, 142°15'E, <50m, 31.vii-3.viii.1984, RJK acc.84.160 (worker); Madang Prov., 40km W of Madang, 05°13'S, 145°25'E, 140m, 1.ii.1989, P.S. Ward #10113-24 (2 workers). Type deposition: Holotype in MCZC, 1 paratype each in ANIC, BMNH, BPBM, QM.

DESCRIPTION. *Worker.* Dimensions (holotype cited first): TL c. 6.00, 5.49-6.65; HL 1.59, 1.47-1.69; HW 1.53, 1.43-1.57; CI 96, 93-99; SL 1.90, 1.72-2.06; SI 124, 120-131; PW 1.15, 1.06-1.31; MTL 2.28, 1.93-2.34 (6 measured).

Clypeus in profile very weakly convex or almost straight in some specimens, narrowly rounding posteriorly into weakly medially impressed basal margin. Frontal triangle weakly impressed. Frontal carinae sinuate with very weakly raised margins; central area rather flat with frontal furrow weakly indicated for most of its length. Sides of head in front of eyes only weakly convex, almost straight, strongly converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes moderately convex, clearly breaking lateral cephalic outline in full face view. Ocelli lacking, relative positions indicated by shallow punctures in sculpturation. Pronotum in dorsal view with humeri rounded. Mesosoma in profile with pronotum very strongly convex, very high, anterior face vertical; summit narrow with short, median, longitudinal furrow; promesonotal suture moderately impressed; mesonotal dorsum weakly convex; metanotal groove lacking, its position indicated by depression in mesosomal outline; propodeal dorsum descending in shallow curve into oblique declivity. Petiole with anterior face straight, posterior face convex; dorsum armed with four, acute, subequal spines; dorsal pair situated closer to each other than to lateral spines, tips slightly bent backwards. Subpetiolar process acute anteriorly, bluntly angular posteriorly. Anterior face of first gastral segment marginally lower than apices of dorsal petiolar spines.

Mandibles very finely, mostly longitudinally rugose. Head, mesosoma and gaster finely

shagreened, rather polished; pronotal sculpturation becoming laterally reticulate; lower sides of mesosoma, notably meso- and metapleurae rather strongly reticulate-rugose. Petiole with anterior face finely reticulate, sculpturation more distinct on sides. Dorsal surfaces of head, mesosoma and gaster with piliferous pits and shallow punctures of various densities.

Mandibles with a few, rather short, semierect hairs near masticatory borders. Anterior clypeal margin with 1 or 2 relatively long, erect, anteriorly directed setae medially and several shorter setae laterally. A few paired, rather short, erect hairs near anterior and basal clypeal margins, several hairs along frontal carinae and pair of distinctly longer hairs on vertex. Summit of mesosoma with tuft of erect, somewhat curved hairs, more than half of greatest diameter of eyes in length (number of hairs in some specimens reduced to one or two probably due to abrasion). Posterior margins of gastral segments with a few, medium length, erect hairs, more abundant on ventral surfaces and around gastral apex. Very short, mostly appressed or decumbent hairs in various densities arising from pits and punctures over all body surfaces.

Colour. Black with only mandibular masticatory borders, condylae, tips of apical funicular segments and joints between trochanters and femora, reddish brown. Tibiae towards their distal ends a shade lighter.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis conspicua* occurs in Irian Jaya, Papua New Guinea and the adjacent Biak Island. It has been collected only on a handful of ocassions and nothing is known about its nesting habits. *Polyrhachis conspicua* is a spectacular species and is similar to *P. inflata* described below. Both share the exceptionally high, narrowly convex pronotum, which features a short, longitudinal furrow along its summit. However, they differ in size (HL 1.47-1.68 in *P. conspicua* versus 1.68-1.81 in *P. inflata*) and in general body sculpturation that is smooth and polished in *P. conspicua* and closely reticulate-punctate and opaque in *P. inflata*.

Polyrhachis debilis Emery, 1887

Polyrhachis laevior var. *debilis* Emery, 1887: 240. (Variant spelling.) Syntype workers. Original localities: NEW GUINEA, Fly River (L.M. D'Albertis); INDONESIA, Aru Is (O. Beccari). MCSN, MHNG, NMNH, QM (examined).

Polyrhachis levior var. *debilis* Emery. Dalla Torre, 1893: 264.

Polyrhachis (Cyrtomyrma) rastellata ssp. *laevior* var. *debilis* Emery. Emery, 1925: 208. (Variant spelling).

Polyrhachis (Cyrtomyrma) debilis Emery. Donisthorpe, 1938: 265. Description of queen. Raised to species.

REMARKS. *P. debilis* is relatively similar to *P. yorkana* from Australia, with their distinguishing characters provided under the latter. *P. debilis* occurs from Papua New Guinea to the islands of eastern Indonesia. Specimens of *P. debilis* previously recorded from Australia (Kohout, 2000) belong to *P. yorkana*. Although the type locality of *P. debilis* (Fly River, Papua New Guinea) is situated just across Torres Strait from Cape York Peninsula, it apparently does not occur in Australia.

Polyrhachis dorsena sp. nov.
(Fig. 8G-H)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, West Sepik Prov., Torricelli Mtns, 1-2km NE of Lumi, 03°28'S, 142°02E, 400-500m, 4-13.viii.1984, R.J. Kohout acc. 84.232 (worker). PARATYPES: data as for holotype (19 workers, 7 alate ♀). Type deposition: Holotype, most paratype workers and paratype ♀ in ANIC; 3 paratype workers and 1 paratype ♀ in BMNH, MCZC and QM; 1 paratype worker each in AMNH, BPBM, CASC and NMNH. OTHER MATERIAL: INDONESIA, WEST IRIAN, Wisselmeren, Urapura, Kamo Valley, 03°55'S, 136°15'E, 1530m, 15.viii.1955 (JLG) (w). PAPUA NEW GUINEA, East Sepik Prov., Maprik, 150m, 29.xii.1959-17.i.1960 (TCM) (w); Hayfield nr Maprik, c. 150m, 27-28.vi.1972 (RWT acc. 72.494) (w); Eastern Highlands Prov., Kassam, 49km E of Kainantu, 1350m, 30.x.& 7.xi.1959 (TCM) (w); Northern Prov., Managalase Area, 2500-3000ft, viii.1965 (R. Pullen) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.35, 5.80-6.35; HL 1.65, 1.50-1.65; HW 1.62, 1.40-1.62; CI 98, 93-98; SL 2.06, 1.78-2.06; SI 127, 124-131; PW 1.25, 1.12-1.25; MTL 2.40, 2.15-2.40 (6 measured).

Clypeus in profile very weakly convex, narrowly rounding posteriorly into weakly medially impressed basal margin. Frontal triangle very weakly impressed, indistinct. Frontal carinae sinuate with very weakly raised margins; central area rather flat with weak frontal furrow. Sides of head in front of eyes weakly convex, converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes weakly convex, in full face view not reaching lateral cephalic outline. Ocelli lacking, relative position of median ocellus indicated by shallow puncture in sculpture. Pronotum in dorsal view with humeri widely rounded; greatest width of pronotal dorsum at mid-length of segment. Mesosoma in profile with pronotum strongly

convex, its anterior face rising steeply, vertically in some specimens; promesonotal suture distinct; mesonotal dorsum almost flat, gently descending posteriorly; metanotal groove weakly indicated; propodeal dorsum and declivity forming single, uninterrupted curve in profile. Petiole with anterior face straight, posterior face convex; dorsum armed with four subequal spines; dorsal pair closer to each other than to lateral spines, tips slightly bent backwards. Subpetiolar process acute anteriorly, bluntly angular posteriorly. Anterior face of first gastral segment marginally lower than apices of dorsal petiolar spines.

Mandibles very finely longitudinally rugose with numerous piliferous pits towards bases. Head, mesosoma and gaster rather polished, finely shagreened with sculpturation distinctly more reticulate-rugose laterally, notably on meso- and metapleurae. Petiole with anterior face finely, mostly transversely reticulate with sculpture on posterior face distinctly finer and more polished; lower portions of petiole distinctly reticulate-rugose. All dorsal body surfaces with numerous piliferous pits and shallow punctures.

Mandibles with a few short, semierect hairs along masticatory borders. Anterior clypeal margin with a few anteriorly directed setae medially and several shorter setae laterally. A few pairs of erect hairs near anterior and basal clypeal margins and along frontal carinae. Tuft of medium length, somewhat curved hairs on summit of mesonotum, some almost as long as greatest diameter of eye. A few rather isolated hairs on anterior faces of fore coxae and ventral surfaces of fore femora. Numerous erect hairs along posterior margins of gastral segments, more abundant ventrally. Very short, appressed hairs arising from pits and shallow punctures over most body surfaces.

Colour. Black; mandibular masticatory borders, condylae, tips of apical funicular segments and joints between trochanters and femorae, reddish-brown. Antennae and legs medium reddish-brown; tarsi black. Anterior and ventral portions of gaster rather diffusely blotched with reddish-brown.

Queen. Dimensions: TL c. 8.06; HL 1.84; HW 1.68; CI 91; SL 2.15; SI 128; PW 1.84; MTL 2.72 (1 measured). Apart from sexual characters, very similar to worker except: pronotal humeri widely rounded, mesoscutum slightly transverse, with evenly rounded anterior margin; median line short; parapsides rather flat, slightly elevated posteriorly; mesoscutum in profile distinctly convex anteriorly, with flat dorsum. Mesoscutellum convex, well elevated above dorsal plane of mesosoma. Metanotal groove distinct. Propodeal dorsum weakly convex, widely rounding into oblique declivity. Other characters, including sculpturation and pubescence as in worker.

Males unknown. Immature stages (larvae and pupa) in ANIC collection.

REMARKS. *Polyrhachis dorsena* is evidently restricted to New Guinea. The type colony was collected from a silk nest built on the underside of a palm leaf in rainforest. *Polyrhachis dorsena* is rather similar to *P. lybosa*, described below, with distinguishing characters listed under that species. It also resembles *P. conspicua*, however, *P. dorsena* has the pronotal dorsum less strongly convex and lacks a medial, longitudinal furrow along its summit.

Polyrhachis euryala Fr. Smith, 1863

Polyrhachis euryalus Fr. Smith, 1863: 17. Syntype workers. Type locality: INDONESIA, Misool I. (A.R. Wallace), OXUM, BMNH (examined).

Polyrhachis euryalus Fr. Smith. Mayr, 1872: 138. Junior synonym of *P. rastellata* (Latreille, 1802).

Polyrhachis rastellata var. *euryalus* Fr. Smith. Emery, 1900: 720. Revived from synonymy and variety of *P. rastellata* (Latreille, 1802).

Polyrhachis rastellata ssp. *euryala* var. *torricelliana* Viehmeyer. Viehmeyer, 1914: 50. Junior synonym of *P. rastellata euryala* Fr. Smith.

Polyrhachis (Cyrtomyrma) rastellata ssp. *euryalus* Fr. Smith. Emery, 1925: 208. Subspecies of *P. rastellata* (Latreille, 1802) and combination in *P. (Cyrtomyrma)*.

Polyrhachis (Cyrtomyrma) euryalus Fr. Smith. Donisthorpe, 1938: 259, fig 10. Reviewed status as species.

REMARKS. From the synonymic list above, it appears that various authors were uncertain as to the precise status of this species. Mayr (1862), Dalla Torre (1893) and Bingham (1903) all considered *P. euryala* to be a junior synonym of *P. rastellata*, while Emery listed it as a variety (1900) and later (1925) as a subspecies of *P. rastellata*. Donisthorpe (1938) reinstated *P. euryala* as a good species, redescribed it and noted that 'the pronotum is broadest in the middle' and that 'It is a smaller much more slender ant than *rastellata*'. Bolton (1995) and Dorow (1995) both listed *P. euryala* as a distinct species in their catalogues, and I am confident it is a valid species. As Donisthorpe noted, *P. euryala* is distinctly more slender than *P. rastellata* with the greatest width of the pronotal dorsum in the middle of its length. *Polyrhachis rastellata* is more robust, notably across the pronotum which is widest across, or just behind the shoulders. *Polyrhachis euryala* appears to be an uncommon species with a rather patchy distribution from the eastern islands of Indonesia

across New Guinea. Several specimens from Pes Mission (Papua New Guinea) compare well with the holotype of *P. euryala* from Mysool I. in spite of their slightly larger size (HL 1.53 in syntypes versus 1.56-1.68 in compared specimens) and colour of their appendages (reddish-brown in both syntypes versus very dark brown or black in the modern specimens).

Polyrhachis goramensis Emery, 1887
(Fig. 9A-B)

Polyrhachis rastellata var. *garamensis* Emery, 1887: 239. Syntype workers. Type locality: INDONESIA, Goram I. (= Seram I.), (L.M. D'Albertis), MCSN (examined).
Polyrhachis (Cyrtomyrma) rastellata ssp. *euryalus* var. *goramensis* Emery. Emery, 1925: 208. Combination in *P. (Cyrtomyrma)*.
Polyrhachis (Cyrtomyrma) euryalus var. *goramensis* Emery. Donishorpe, 1938: 260.
Polyrhachis goramensis Emery. Kohout, 1998: 527. Raised to species.

REMARKS. *Polyrhachis goramensis* is characterised by: a distinctly swollen pronotal dorsum; a moderately impressed pro-mesonotal suture; short, acute propodeal spines that are sometimes reduced to a pair of tubercules, and distinctly elongated lateral petiolar spines. It is rather similar to *P. integra*, described below, with the main distinguishing characters given under that species. *Polyrhachis goramensis* appears to be endemic to Seram I.

Polyrhachis hybosa sp. nov.
(Fig. 9C-D)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, Northern Prov., Kokoda, 1200ft, iv.1933 (L.E. Cheesman #350, B.M. 1933-577) (w) PARATYPES: data as for holotype (2 workers). Type deposition: Holotype in BMNH, 1 paratype worker each in MCZC and QM. OTHER MATERIAL: PAPUA NEW GUINEA, Northern Prov., Pongani R., Boikiki Pltn, c. 8km NNE of Afore, c. 09°06'S, 148°25'E, c. 500m, 29-30.ix.1984 (RJK acc. 84.386) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 7.11, 6.85-7.11; HL 1.81, 1.72-1.81; HW 1.75, 1.65-1.78; CI 97, 96-98; SL 2.34, 2.28-2.34; SI 134, 131-138; PW 1.37, 1.31-1.40; MTL 2.90, 2.81-2.90 (3 measured).

Clypeus in profile virtually straight, rounding posteriorly into very shallow basal margin. Frontal triangle weakly impressed, rather indistinct. Frontal carinae sinuate with raised margins; central area medially concave with relatively short, weakly impressed frontal furrow. Sides of head in front of eyes convex, converging towards mandibular bases; behind eyes sides widely rounding into broadly convex occipital margin. Eyes weakly convex, almost flat, situated well inwards from occipital corners; not reaching lateral cephalic outline in full face view. Ocelli lacking. Pronotum in dorsal view widely rounded; greatest pronotal width at mid-length of segment. Mesosoma in profile with pronotum strongly convex, distinctly swollen, anterior face rising steeply towards summit; promesonotal suture distinct, rather flat in profile; mesonotal dorsum weakly convex, gently descending posteriorly; metanotal groove faintly indicated; outline of propodeal dorsum flat, rounding into steep declivity in uninterrupted curve. Petiole in profile virtually triangular, with anterior and posterior faces straight; dorsum armed with four short, subequal teeth; dorsal pair distinctly closer to each other than to lateral spines, tips slightly bent backwards. Subpetiolar process acute anteriorly, rounded posteriorly. Anterior face of first gastral segment straight with anterodorsal margin lower than full height of petiole.

Mandibles finely, longitudinally rugose with numerous piliferous pits. Head, mesosoma and gaster finely shagreened, sculpturation marginally coarser on lower parts of mesosoma; meso- and metapleurae weakly reticulate-rugose. Dorsal half of petiole finely, transversely reticulate, sulpturation distinctly coarser around base. Numerous shallow punctures and piliferous pits scattered over all body surfaces.

Mandibles with several rather short, semierect hairs on masticatory borders. Anterior clypeal margin with a few medium length, anteriorly directed setae medially and a few short setae laterally. A few pairs of medium length hairs near anterior and basal clypeal margins and along frontal carinae; single pair of erect hairs on vertex. A few longer, semierect hairs on posterior faces of fore coxae and along posterior margins of apical gastral segments, more abundant ventrally. Whole body with very short, appressed hairs arising from numerous pits.

Colour. Black; mandibular teeth, condylae and tips of apical funicular segments reddish-brown. Legs medium to dark reddish-brown with proximal ends of tibiae and tarsi black. Posterior margins of gastral segments somewhat diffusely reddish-brown.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis hybosa* is known only from the Northern Province of Papua New Guinea. Nothing is known about its nesting

habits with all specimens taken foraging on low vegetation. *Polyrhachis hybosa* is very similar to *P. dorsena*, described above, with both species featuring a distinctly swollen pronotal dorsum and widely rounded pronotal shoulders. However, the mesosoma in *P. hybosa* is distinctly more robust in comparison with that of *P. dorsena*. Also, the eyes in *P. hybosa* are rather flat and they do not reach the lateral cephalic outline in full face view. The eyes in *P. dorsena* are moderately convex and with the head in full face view, they marginally exceed the lateral outline.

Polyrhachis inducta sp. nov.
(Fig. 9E-F)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, Morobe Prov., Bulolo, 21.xii.1970, B.B. Lowery (worker). PARATYPES: data as for holotype (12 workers). Type distribution: Holotype and 2 paratypes in ANIC; 2 paratypes each in BMNH, MCZC, NMNH and QM.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 5.34, 5.09-5.95; HL 1.43, 1.34-1.50; HW 1.37, 1.25-1.43; CI 96, 93-98; SL 1.87, 1.72-1.90; SI 136, 127-140; PW 1.12, 1.00-1.18; MTL 2.12, 2.00-2.21 (13 measured)

Clypeus in profile straight, with indication of rather weak, median tubercule just before narrowly rounding into medially impressed basal margin. Frontal triangle very weakly impressed, indistinct. Frontal carinae sinuate with weakly raised margins; central area relatively narrow, weakly concave with short frontal furrow. Sides of head in front of eyes almost straight, converging towards mandibular bases; behind eyes sides widely rounding into convex occipital margin. Eyes convex, in full face view distinctly breaking lateral cephalic outline. Ocelli lacking; vertex with only shallow punctures indicating their relative positions. Pronotum in dorsal view widely rounded, greatest width of pronotal dorsum at mid-length of segment. Mesosoma in lateral view with pronotum only weakly convex, mesonotal and propodeal dorsa more highly convex; promesonotal suture distinct; metanotal groove lacking; propodeal dorsum armed with relatively short, acute, upturned spines; declivity virtually vertical. Petiole with anterior face straight, posterior face convex; dorsum armed with four spines; dorsal pair triangular; lateral pair more slender and distinctly longer. Subpetiolar process acute anteriorly, bluntly angular posteriorly. Anterior face of first gastral segment higher than apices of dorsal petiolar spines.

Mandibles finely rugose. Head, mesosoma and gaster shagreened; sculptural intensity markedly increasing laterally with sides of mesosoma and base of petiole distinctly reticulate-rugose; meso- and notably metapleaurae deeply, irregularly, foveolate-rugose. Whole body covered with numerous piliferous pits and shallow punctures.

Mandibles with numerous semierect hairs along masticatory borders and very short appressed hairs towards bases. Anterior clypeal margin with a few medium length, anteriorly directed setae medially and several very short setae laterally. A few pairs of longer, erect hairs near anterior and basal clypeal margins and along frontal carinae; single pair of long hairs on vertex. Fore coxae with a few erect hairs. Posterior margins of gastral segments with numerous erect hairs. Whole body with dense, short, appressed and decumbent hairs, those on dorsum of mesosoma more erect than hairs on head and gaster.

Colour: Black; clypeus, sides of head and gaster diffusely reddish-brown. Antennal scapes very dark brown with distal ends and funiculi distinctly lighter. Mandibles, coxae and tarsi dark reddish-brown with mandibular masticatory borders, trochanters, femora and tibiae a shade lighter.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis inducta* is apparently restricted to New Guinea with the only known specimens collected from a nest under the bark of tree. It is rather similar to *P. nomo* and *P. decumbens* with which it shares the dense cover of appressed and decumbent hairs. It differs from both in the outline of the mesosoma that in *P. decumbens* and *P. nomo* is distinctly more convex anteriorly with the mesonotum and propodeum rather weakly rounding into an obliquely descending propodeal declivity. In *P. inducta* the outline of the pronotal dorsum is only weakly convex with the mesosomal and propodeal dorsa distinctly higher and curving abruptly into a vertical propodeal declivity. *Polyrhachis inducta* also differs by the presence of distinct propodeal spines that are virtually absent in *P. decumbens* and *P. nomo*.

Polyrhachis inflata sp. nov.
(Fig. 9G-H)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, West Sepik Prov., Torricelli Mts, Lumi, 03°29'S, 142°02'E, x.1984, D. Waisi (worker). PARATYPES: data as for holotype (2 workers); ditto, 1-2km NE of Lumi, 400-500m, 11-13.viii.1984, rf, RJK acc. 84.283

(♀). Madang Prov., Adalbert Mts, Wanuma, 04°36'S, 145°06'E, viii.1968, N.L.H. Krauss (1 workers). Gulf Prov., Ivimka camp, Lakekamu Basin, 07.7°S, 146.8°E, 120m, 11-20.xi.1996, Malaise trap, R.R. Snelling (1 worker). Type deposition: Holotype worker (QMT99345) and paratype ♀ in QM; 1 paratype worker each in ANIC, BMNH, BPBM and MCZC.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 7.26, 6.50-7.26; HL 1.81, 1.68-1.84; HW 1.72, 1.62-1.81; CI 95, 94-98; SL 2.34, 2.09-2.34; SI 136, 128-136; PW 1.37, 1.28-1.40; MTL 2.78, 2.43-2.81 (5 measured).

Clypeus in profile almost straight, with weak median tubercle just before narrowly rounding into weakly medially impressed basal margin. Frontal triangle weakly impressed. Frontal carinae sinuate with weakly raised margins; central area almost flat with frontal furrow indicated along most of its length. Sides of head in front of eyes almost straight, strongly converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Ocelli lacking, shallow punctures indicating relative positions of lateral ocelli poorly visible under overlying sculpturation. Pronotum in dorsal view widely rounded; greatest width of pronotal dorsum at mid-length of segment. Mesosoma in profile with pronotum strongly convex, very high, anterior face very steep; summit narrow with short, median, longitudinal furrow; promesonotal suture distinct; mesonotal dorsum virtually straight except for depression indicating position of metanotal groove; propodeal dorsum descending in open, uninterrupted curve into oblique declivity. Petiole with anterior face straight, posterior face very weakly convex; dorsum armed with four subequal spines; dorsal pair closer to each other than to lateral spines, tips slightly bent backwards. Subpetiolar process acute anteriorly, rounded posteriorly. Anterior face of first gastral segment straight, rounding in even curve onto dorsum of segment.

Mandibles finely, longitudinally striate with numerous piliferous pits. Head, mesosoma and petiole very closely reticulate-punctate; sculpturation on sides of mesosoma more coarse, becoming reticulate-rugose on meso- and metapleurae. Petiole finely, mostly transversely reticulate, distinctly reticulate-rugose around base. Gaster rather strongly shagreened, sculpture generally less coarse than on head and mesosoma. All dorsal body surfaces with numerous piliferous pits and punctures.

Mandibles with numerous semierect hairs on masticatory borders. Anterior clypeal margin with a few anteriorly directed setae medially and several shorter setae laterally. Paired, relatively long, erect hairs near anterior and basal clypeal margins and along frontal carinae; single longer pair on vertex. One or 2 long, erect hairs on anterior and posterior faces of fore coxae. Numerous, medium length, erect hairs lining posterior margins of gastral segments; ventral surfaces with hairs distinctly more abundant, posteriorly directed and with rather dense cover of decumbent hairs. Abundant, very short, appressed hairs arising from numerous pits over all dorsal body surfaces.

Colour. Black, with only mandibular teeth, condylae, extreme tips of apical funicular segments and narrow band on trochanters, medium reddish-brown.

Queen. Dimensions: TL c. 8.11; HL 1.93; HW 1.72; CI 89; SL 2.34; SI 136; PW 1.84; MTL 3.17 (1 measured). Apart from sexual characters, very closely resembling worker except: pronotal humeri widely rounded; mesoscutum in profile widely rounded anteriorly, dorsum rather flat; mesoscutum in dorsal view only marginally wider than long, lateral margins converging anteriorly into narrowly rounded anterior margin; median line clearly indicated, bifurcate posteriorly; parapsides rather flat, weakly raised posteriorly. Mesoscutellum in profile convex, higher than mesoscutum; metanotal groove distinct. Propodeal dorsum descending into oblique declivity in narrow curve. Sporadic pilosity and sculpturation as in worker, except mesothoracic epimera and episterna very finely reticulate without punctures or piliferous pits.

Male and immature stages unknown.

REMARKS. *Polyrhachis inflata* is evidently endemic to New Guinea. Nothing is known about its nesting habits with specimens of the type series collected in a rainforest clearing on trunks of recently felled trees. *Polyrhachis inflata* is probably related to *P. luctuosa* Emery, 1921 (Fig. 10G-H) with both distinguished from all other known New Guinean species of the subgenus by the very closely reticulate-punctate sculpturation of their body, giving them a distinct opaque appearance. However, *P. inflata* is easily separated by its exceptionally high pronotal dorsum which bears a well-defined, median, longitudinal furrow along its summit. The pronotum in *P. luctuosa* is not swollen and has no furrow. With its highly raised pronotum, *P. conspicua* also resembles *P.*

inflata, but the body sculpturation in *P. conspicua* is rather smooth and polished.

Polyrhachis integra sp. nov.
(Fig. 10A-B)

MATERIAL. HOLOTYPE: INDONESIA, IRIAN JAYA, P.T. Freeport Concession, Wapoga camp, 03.14°S, 136.57°E, 3450ft, 26.iv.1998, R.R. Snelling #98.201 (worker). Unique holotype in MLAC.

DESCRIPTION. *Worker*. Dimensions: TL c. 6.30; HL 1.65; HW 1.48; CI 90; SL 2.09; SI 141; PW 1.31; MTL 2.59.

Clypeus in profile almost straight, with short median carina just before rounding into medially impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate with margins only moderately raised; central area with weakly impressed frontal furrow. Sides of head in front of eyes convex, anteriorly converging towards mandibular bases; behind eyes sides strongly converging into broad occipital margin. Eyes moderately convex, breaking lateral cephalic outline in full face view. Ocelli lacking; relative position of median ocellus indicated by shallow depression. Pronotum in dorsal view with sides widely rounded; greatest pronotal width at mid-length of segment. Mesosoma in profile with highly raised, strongly convex pronotum; promesonotal suture shallow but well defined; mesonotal dorsum almost straight; metanotal groove only faintly visible dorsally, in lateral view indicated by shallow depression in mesosomal outline; propodeum armed with pair of short, upturned, acute spines; declivity rather short, almost vertical. Petiole with anterior face straight, posterior face weakly convex; armed with pair of, acute dorsal teeth, situated close together, with tips bent backwards; pair of lateral teeth distinctly shorter. Subpetiolar process acute anteriorly, widely rounded posteriorly. Anterior face of first gastral segment lower than height of petiole, widely rounding onto dorsum of segment.

Mandibles very finely, longitudinally rugose. Head, mesosoma and gaster rather smooth, very finely shagreened, with numerous, shallow minute punctures. Intensity of sculpturation distinctly increasing laterally, lower portions of mesosoma, notably meso- and metapleurae and petiole, rather coarsely reticulate-rugose.

Several erect to semierect, short to medium length hairs fringing mandibular masticatory borders, numerous appressed hairs arising from pits towards mandibular bases. Anterior clypeal margin with several relatively long, anteriorly directed setae medially and a few very short setae laterally. A few pairs of hairs near anterior and basal clypeal margins and along frontal carinae; single pair on vertex. Gaster with numerous medium length hairs along posterior margins of segments and around apex. Sides of head, mesosoma, petiole and dorsum of first gastral segment completely hairless. Extremely short appressed pubescence, arising from pits and shallow minute punctures in various densities over all body surfaces.

Colour. Black; mandibular masticatory borders, condylae, extreme tips of apical funicular segments, joints between trochanters and femorae of mid and hind legs and tarsal claws medium to dark reddish-brown.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis integra* is similar to *P. goramensis* (Fig. 9A-B) from Indonesia. Both have a rather massive pronotum with widely rounded sides, the mesosomal dorsum rapidly descending from the summit of the pronotum to the declivity and short, but distinct, propodeal spines. However, they are easily distinguished, with *P. integra* having a distinctly higher pronotum, the mesonotum virtually straight in lateral view, and the lateral petiolar spines reduced to short teeth. In *P. goramensis* the mesonotal dorsum is convex in lateral view and the widely diverging lateral petiolar spines are more than twice as long as the dorsal pair.

Polyrhachis kyawthani sp. nov.
(Fig. 10C-D)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, New Ireland Prov., East Coast, 3km S of Konos, 03°09'S, 151°43'E, <50m, 22.vii.1984, R.J. Kohout acc. 84.105 (worker). PARATYPES: data (and nest) as for holotype (58 workers, dealate ♀). Type deposition: Holotype, most paratype workers and paratype ♀ in ANIC; 2 paratype workers each in AMNH, BMNH, BPBM, CASC, MCZC, NMNH and QM. OTHER MATERIAL: PAPUA NEW GUINEA. New Ireland Prov., 50km from Kavieng, 50-130m, 3.vii.1959 (JLG) (w); 'Camp Bishop', 12km up Kait R., 240m, 15.vii.1956 (E.J. Ford, Jr) (w); Gilingil Pltn, 2m, 6.vii.1956 (JLG) (w).

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 7.06, 6.35-7.56; HL 1.65, 1.56-1.75; HW 1.56, 1.43-1.62; CI 94, 92-96; SL 2.15, 2.03-2.25; SI 138, 135-144; PW 1.25, 1.15-1.31; MTL 2.59, 1.59-2.71 (12 measured).

Clypeus in profile very weakly convex, narrowly rounding into weakly impressed basal

margin. Frontal triangle weakly indicated. Frontal carinae sinuate with weakly raised margins; central area rather flat with frontal furrow clearly indicated for most of its length. Sides of head in front of eyes very weakly convex, converging towards mandibular bases; behind eyes sides rounding into broadly convex occipital margin. Eyes weakly convex, in full face view not reaching lateral cephalic outline. Ocelli lacking, relative positions indicated by shallow punctures in sculpture. Pronotum in dorsal view widely rounded, humeri in some specimens subangular; greatest pronotal width at mid-length of segment. Mesosoma in lateral view with pronotum weakly convex, almost flat, narrowly rounding into weakly impressed promesonotal suture; mesonotal dorsum convex; metanotal groove indicated by shallow depression in outline and faint line in some specimens; propodeum unarmed, dorsum widely rounding into virtually vertical declivity. Petiole in profile biconvex; dorsum armed with rather small, acute, subequal teeth; tips of dorsal pair distinctly bent backwards. Subpetiolar process acute anteriorly, widely rounded posteriorly. First gastral segment with anterior face lower than apices of petiolar spines, widely rounding onto dorsum of segment.

Mandibles very finely rugose with piliferous pits, density reducing towards bases. Head, mesosoma and gaster finely shagreened dorsally; intensity of sculpturation increasing laterally with meso- and metapleaurae reticulate-rugose. Petiole very finely, mostly transversely reticulate, distinctly reticulate-rugose around base. Rather shallow piliferous pits scattered over most body surfaces, but almost completely absent from rather polished dorsum of mesosoma.

Mandibles with numerous, medium length, curved hairs along masticatory borders. Anterior clypeal margin usually with 2 long, anteriorly directed setae medially and several rather short setae laterally. Mostly paired, medium length, erect hairs near anterior and basal clypeal margins and along frontal carinae; pair of long, somewhat forward-curved hairs on vertex. Pair of long, erect hairs on anterior faces of fore coxae, several shorter, somewhat isolated, erect hairs ventrally on trochanters and femora. Numerous, medium length, erect hairs along posterior margins of gastral segments, more abundant on ventral surfaces.

Colour. Black; mandibular teeth, condylae, tips of apical funicular segments and legs medium reddish-brown. Coxae and tarsi black. Apex of gaster diffusely reddish-brown.

Queen. Dimensions: TL e. 9.32; HL 2.09; HW 1.87; CI 89; SL 2.43; SI 130; PW 1.93; MTL 3.21 (1 measured). Apart from sexual characters, similar to worker except: pronotal humeri evenly and widely rounded; mesoscutum marginally wider than long, lateral margins distinctly converging anteriorly, forming distinctly narrowly rounded anterior margin; median line short, weakly indicated; parapsides rather flat, slightly raised posteriorly; mesoscutum in profile with widely rounded anterior face and very weakly convex dorsum. Mesoscutellum weakly convex, marginally elevated above dorsal plane of mesosoma; metanotal groove distinct. Propodeal dorsum weakly convex, rounding abruptly into virtually vertical declivity. Very fine body sculpturation, rather sporadic pilosity and polished appearance as in worker.

Males unknown. Immature stages (eggs, larvae and pupae) present in ANIC spirit collection.

REMARKS. *Polyrhachis kyawthani* is known only from New Ireland. The specimens of the type series were collected from a silk nest attached to the underside of a leaf on a low tree in rainforest. *Polyrhachis kyawthani* is very similar to *P. aporema* described above with the main characters distinguishing them listed under the latter.

Polyrhachis leonidas Forel, 1901

Polyrhachis leonidas Forel, 1901: 34. Syntype workers, queen. Type locality: BISMARCK ARCHIPELAGO, Mioko (F. Dahl). MHNG (examined).

Polyrhachis (Cyrtomyrma) leonidas Forel. Emery, 1925: 208; Donisthorpe, 1938: 267.

REMARKS. *Polyrhachis. leonidas* is relatively similar to *P. barryi*, described above, with distinguishing characters listed under the latter. *Polyrhachis leonidas* appears to be a rather rare species apparently limited to the Bismarck Archipelago. Besides the types, I have only seen specimens collected by J.L. Gressitt at Keravat, Gazelle Pen. (East New Britan Prov., Papua New Guinea) (MCZC, BPBM, QM).

Polyrhachis levior Roger, 1863

Polyrhachis laevissimus Fr. Smith, 1859: 141. Holotype worker. Type locality: INDONESIA, Aru I. (A.R. Wallace), OXUM (examined). [Junior homonym of *P. laevissima* Fr. Smith, 1858:64].

Polyrhachis levior Roger, 1863: 8. Replacement name.

Polyrhachis rastellata r. *laevior* Roger. Forel, 1893: 21 (variant spelling).

Polyrhachis (Cyrtomyrma) levior Roger. Forel, 1915: 110. Combination in *P. (Cyrtomyrma).*

Polyrhachis (Cyrtomyrma) rastellata spp. *laevior* Roger. Emery, 1925: 208 (variant spelling).

Polyrhachis (Cyrtomyrma) levior Roger. Donisthorpe, 1938: 248, fig. 1. Reviewed status as species.

REMARKS. *Palyrhachis levior* is known only by the unique holotype (missing its head) from Aru I, Indonesia. Its distinctly bilobed pronotal humeri resemble those of *P. albertisi* Emery (see above). The mesosoma features a rather steeply raised pronotum and weakly convex mesonotum and propodeum. The promesonotal suture is distinct but the metanotal groove lacking, its position indicated only by a slight depression in the mesosomal outline. The propodeal spines are relatively long, somewhat dorso-ventrally compressed, directly dorso-laterally and posteriorly, with their bases set well apart. The dorsum of the petiole is furnished with four sharp teeth of equal length.

Polyrhachis linae Donisthorpe, 1938

Polyrhachis (Cyrtomyrma) linae Donisthorpe, 1938: 262, fig. 12. Syntype workers, queens. Type locality: NEW GUINEA, Cyclops Mts, Mt Lina (L.E. Cheesman), BMNH, QM (examined).

REMARKS. *Polyrhachis linae* is somewhat simlar to *P. debilis*, but it differs by its larger size and more steeply convex pronotum that is widest just behind the narrowly rounded humeri. The propodeal spines are short, but distinct. In contrast, specimens of *P. debilis* are distinctly smaller with a weakly convex pronotal profile. The pronotal humeri are widely rounded and the propodeal spines very short, present as tubercular or completely absent. *Polyrhachis linae* appears to be a rather uncommon, but widespread, New Guinean species with several colonies collected recently by R. Snelling at the Lakekamu Basin (Gulf Prov., Papua New Guinea).

Polyrhachis luctuosa Emery, 1921 (Fig. 10G-H)

Polyrhachis (Cyrtomyrma) luctuosa Emery, 1921: 25; Emery, 1925: 208; Donisthorpe, 1938: 261. Holotype worker. Type locality: NEW GUINEA (no further data), MCSN (examined).

REMARKS. *Polyrhachis luctuosa* is closely related to *P. inflata*, with both distinguished from all other known New Guinean species by the very closely reticulate-punctate sculpturation of their body, giving them a distinct, opaque appearance. However, *P. inflata* is easily distinguished from P. *luctuosa* by its exceptionally high pronotal dorsum which bears a well-defined, median, longitudinal furrow along its summit. The pronotum in *P. luctuosa* is not swollen and has no furrow on its summit. *Polyrhachis luctuosa* is apparently very rare and, besides the type, only one additional specimen was collected by RWT at Hayfield nr Maprik (East Sepik Prov., Papua New Guinea).

Polyrhachis mondoi Donisthorpe, 1938

Polyrhachis (Cyrtomyrma) mondoi Donisthorpe, 1938: 250, fig. 3. Holotype worker. Type locality: NEW GUINEA, PAPUA, Mondo (L.E. Cheesman), BMNH (examined).

REMARKS. *Polyrhachis mondoi* is somewhat similar to *P. australis* from Australia, but differs in several characters. In dorsal view, the pronotum is strongly tranverse and widest just behind the distinctly angular humeri. The mesonotal and propodeal dorsa are somewhat laterally compressed with their sides strongly converging posteriorly. In profile, the mesonotum and propodeum are gently sinuate, with the promesonotal suture distinctly impressed and the indistinct metanotal groove indicated by a weak depression. The propodeal spines are rather short and strongly upturned, and propodeal dorsum slopes into the declivity in an even curve. The petiole is armed with four subequal spines. In contrast, the pronotal humeri in *P. australis* are obtusely angular or narrowly rounded and the sides of the mesosoma are not as strongly laterally compressed. The propodeal spines of *P. australis* are longer and only weakly upturned, and the lateral petiolar spines are distinctly longer than the dorsal pair. *Polyrhachis mondoi* is a relatively common species at suitable localities in New Guinea. It is normally an arboreal nesting species but one colony has been collected from under the bark of a living tree.

Polyrhachis nomo Donisthorpe, 1941 stat. nov. (Fig. 10G-H)

Polyrhachis (Cyrtomyrma) rastellata var. *nomo* Donisthorpe, 1941: 142. Syntype workers. Type locality: NEW GUINEA, Mt Nomo, S of Bougainville (L.E. Cheesman), BMNH, MCZC (examined).

REMARKS. *Polyrhachis nomo* is distinct from *P. rastellata* in having all surfaces of the body covered with short, appressed and decumbent hairs. The pronotal shoulders are widely rounded and the lateral petiolar margins strongly diverging, terminating in slender, acute spines that are distinctly longer than the dorsal pair. In contrast, the pilosity in *P. rastellata* consists of a few scattered hairs on the head, apical portion of the gaster and a tuft of hairs on the summit of the mesosoma. The pronotal dorsum in *P. rastellata* is widest across or just below the narrowly rounded or bluntly angular shoulders. The lateral margins of the petiole are only weakly diverging with

the lateral petiolar spines broad-based and rather short. *Polyrhachis nomo* closely resembles *P. decumbens* from Queensland, described above. Both have a characteristic pile of short, decumbent hairs covering most of the body. Characters distinguishing these two species are described in detail under *P. decumbens*.

Polyrhachis ralumensis Forel, 1901

Polyrhachis ralumensis Forel, 1901: 34. Holotype worker. Type locality: BISMARCK ARCHIPELAGO, Ralum (F. Dahl), MHNG (examined).
Polyrhachis rastellata var. *major* Stitz, Viehmeyer, 1914: 50. Junior synonym of *ralumensis*.
Polyrhachis (Cyrtomyrma) ralumensis Forel, Emery, 1925: 208; Donisthorpe, 1938: 257.

REMARKS. *Polyrhachis ralumensis* is easily distinguished from other species of *Cyrtomyrma* from the Bismarck Archipelago by its large size and exceptionally broad head. It also features three distinct ocelli that are absent in workers of the other species. *Polyrhachis ralumensis* is endemic to the Bismarck Archipelago with the holotype and the syntypes of *P. rastellata* var. *major* collected at neighbouring localities (Ralum and Herbertshöhe, New Britain Province).

Polyrhachis sedlaccki sp. nov.
(Fig. 11A-B)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, Morobe Prov., Bulolo R. Valley, c. 5km N of Wau, 07°17'S, 146°42'E, c. 1000m, 12.vi.1963, rf., J.& M. Sedláček (worker). PARATYPE: data as for holotype (worker). Type deposition: Holotype (Type QMT99346) in QM, paratype in ANIC.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 5.29, 5.59; HL 1.37, 1.40; HW 1.37, 1.40; CI 100, 100; SL 1.62, 1.65; SI 118, 118; PW 1.00, 1.03; MTL 1.93, 1.96 (2 measured).

Clypeus convex in profile, narrowly rounding into medially impressed basal margin. Frontal triangle only weakly impressed. Frontal carinae sinuate with rather flat margins; central area with short frontal furrow. Sides of head in front of eyes weakly convex, strongly converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes convex, in full face view clearly breaking lateral cephalic outline. Ocelli lacking. Pronotum in dorsal view with humeri widely rounded; greatest pronotal width at mid-length of segment. Mesosoma in profile with pronotum strongly convex; promesonotal suture distinct, rather flat; mesonotal and propodeal dorsa weakly convex, rounding into declivity in even curve; metanotal groove lacking. Petiole with anterior face rounding onto rather blunt dorsal margin, posterior face convex; lateral spines long, slender, directed backwards; dorsal pair reduced to minute denticles. Subpetiolar process acute anteriorly, angular posteriorly. Anterior face of first gastral segment higher than dorsum of petiole, narrowly rounding onto dorsum of segment.

Mandibles very finely, superficially sculptured. All body surfaces highly polished, with only very fine, microscopic sculpturation and numerous, very shallow piliferous pits.

Mandibles with several rather short, semierect hairs near masticatory borders. Anterior clypeal margin with a few, anteriorly directed setae medially and several shorter setae laterally. A few, medium length, erect hairs fringing apex of gaster. Extremely short, appressed hairs, arising from numerous pits, in various densities, over all body surfaces.

Colour. Black; mandibles reddish-brown with masticatory borders a shade lighter. Antennae dark brown with distal ends of scapes yellowish-brown and funicular segments progressively lighter towards apex. Legs and gaster rather dark, reddish-brown; tarsi very dark brown.

Sexuals and immature stages unknown.

REMARKS. The holotype and paratype are the only specimens known of this spectacular species and nothing is known about its nesting habits. *Polyrhachis sedlaceki* is easily distinguished from all other New Guinean *Cyrtomyrma* by its highly polished appearance and complete lack of dorsal pilosity. It also differs in the unique shape of the petiole that is armed with two long, posterolaterally directed spines. All other known New Guinean species feature a normal scale-like petiole.

Polyrhachis strumosa sp. nov.
(Fig. 11E-F)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, East Sepik Prov., Maprik, 03°36'S, 143°03'E, 150m, 29.xii.-17.i.1960, T.C. Maa (worker). PARATYPES: data as for holotype (7 workers). Type deposition: Holotype and 1 paratype in MCZC; 2 paratypes in BMNH; 1 paratype each in ANIC, BPBM, CASC and QM.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.80, 6.30-7.26; HL 1.68, 1.53-1.72; HW 1.62, 1.53-1.65; CI 96, 94-96; SL 2.28, 2.11-2.34; SI 141, 137-143; PW 1.50, 1.29-1.54; MTL 2.71, 2.53-2.84 (8 measured).

Clypeus in profile weakly convex, posteriorly rounding into rather flat basal margin. Frontal triangle indistinct. Frontal carinae sinuate with raised margins; central area concave medially with rather distinct frontal furrow. Sides of head in front of eyes convex, converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes convex, in full face view marginally exceeding lateral cephalic outline. Ocelli lacking. Pronotum in dorsal view with humeri distinctly subangular; greatest width of pronotal dorsum just behind shoulders. Mesosoma in profile with pronotum rising towards short summit in rather steep, almost straight line; promesonotal suture distinct; mesonotal dorsum very weakly convex, sloping down posteriorly to feebly indicated metanotal groove; propodeal dorsum weakly convex, rounding into relatively high, virtually vertical declivity. Petiole very broad, transverse, anterior face in profile almost straight, posterior face weakly convex; dorsum armed with four spines; lateral pair slightly longer. Subpetiolar process anteriorly acute, weakly concave posteriorly. Anterior face of first gastral segment straight, narrowly rounding onto dorsum of segment.

Mandibles longitudinally rugose with numerous piliferous pits. Head, mesosoma and gaster shagreened, sculptural intensity increasing laterally to become reticulate-rugose, notably on meso- and metapleurae. Petiole finely, mostly transversely wrinkled dorsally, sculpture coarser at base. Numerous shallow punctures and piliferous pits in various densities over all dorsal surfaces.

Mandibles with several short semierect hairs at masticatory borders. Anterior clypeal margin with a few anteriorly directed setae medially and very few shorter setae laterally. A few pairs of medium length, erect hairs near anterior and basal clypeal margins and along frontal carinae. Gaster with numerous, medium length, erect hairs lining posterior margins of apical segments, more abundant on ventral surfaces.

Colour. Black; mandibular teeth, condylae and distal ends of antennal scapes reddish-brown. Funiculi brown with distal segments progressively lighter towards apices; tip of apical segments light yellowish-brown. Legs medium to dark reddish-brown with fore and middle tibiae a shade lighter; tarsi very dark brown or black.

Sexuals and immature stages unknown.

REMARKS. The type series from Maprik are the only known specimens of *P. strumosa* and its nesting habits are unknown. With its rather massive mesosoma, *P. strumosa* is similar to *P. hybosa*, described above. However, they differ in a number of characters, including the outline of mesosoma which, in *P. strumosa*, features a very short pronotal summit and rather high propodeal declivity. In *P. hybosa* the summit of pronotal dorsum is longer and the propodeal declivity distinctly lower. Also, the pronotal dorsum in *P. strumosa* is widest just behind the more-or-less angular humeri, while the pronotal humeri in *P. hybosa* are widely rounded with the pronotal dorsum widest at its mid-length. The petiolar scale in *P. strumosa* is distinctly transverse, while it is virtually quadrate in *P. hybosa*.

Polyrhachis tuberosa sp. nov.
(Fig. 11G-H)

MATERIAL. HOLOTYPE: PAPUA NEW GUINEA, Milne Bay Prov., Puni Puni Point, 10°12'S, 150°27'E, 24.ix.1960, A. Catley (worker). PARATYPES: data as for holotype (8 workers). Type deposition: Holotype and 2 paratypes in MCZC; 2 paratypes in BMNH; 1 paratype each in ANIC, BPBM, CASC and QM.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.25, 5.80-6.70; HL 1.62, 1.56-1.72; HW 1.56, 1.50-1.72; CI 96, 96-98; SL 1.90, 1.84-2.00; SI 122, 117-123; PW 1.15, 1.12-1.28; MTL 2.25, 2.15-2.34 (9 measured).

Clypeus in profile weakly convex, narrowly rounding posteriorly into rather shallow basal margin. Frontal triangle indistinct. Frontal carinae sinuate with raised margins; central area medially concave with distinct frontal furrow. Sides of head in front of eyes weakly convex, converging towards mandibular bases; behind eyes sides rounding into convex occipital margin. Eyes convex, in full face view clearly breaking lateral cephalic outline. Ocelli lacking. Pronotum in dorsal view with humeri widely rounded; greatest pronotal width at mid-length of segment. Mesosoma in profile with pronotum relatively high, ascending towards rather short summit in very weakly curved line; promesonotal suture distinct, flat in profile; mesonotal dorsum weakly convex; metanotal groove very faintly indicated; propodeal dorsum descending into rather low, oblique declivity in widely open curve. Petiole with anterior face very weakly convex, almost flat; posterior face distinctly convex; dorsum armed with four, rather short, subequal teeth. Subpetiolar process acute anteriorly, bluntly angular posteriorly. Anterior face of first gastral

segment marginally higher than petiole, evenly rounding onto dorsum of segment.

Mandibles very finely, irregularly rugose with shallow piliferous pits. Head, mesosoma and gaster shagreened; intensity of sculpturation increasing laterally, becoming weakly reticulate-rugose on sides of pronotum and mesosoma with meso- and metapleaurae more distinctly sculptured. Petiole finely reticulate dorsally, lower portions more heavily sculptured. Numerous, rather shallow punctures and piliferous pits over most body surfaces.

Mandibles with numerous semierect and curved hairs on masticatory borders. Anterior clypeal margin with usually 2, relatively long, anteriorly directed setae medially and fringe of shorter setae laterally. A few pairs of medium length, erect hairs near anterior and basal clypeal margins and along frontal carinae; single pair of slightly longer hairs on vertex. Summit of mesonotal dorsum with tuft of a few, relatively long, variously curved hairs. Gaster with numerous, erect, somewhat posteriorly directed hairs lining posterior margins of segments, hairs more abundant on ventral surfaces.

Colour: Black; mandibular masticatory borders, condylae and tips of apical funicular segments light reddish- or yellowish-brown. Legs medium to very dark reddish-brown, almost black in some specimens, with distal ends of trochanters and most of tibiae a shade lighter; tarsi and proximal ends of tibiae narrowly black. Gastral segments in most specimens with posterior margins somewhat diffusely reddish-brown.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis tuberosa* is known only from the type locality. According to the data label, specimens of the type series were collected 'ex nest upon pawpaw leaves in association with *Amblypelta lutescens papuensis* Brown'. *Polyrhachis tuberosa* belongs to a group of species of rather similar appearance that are collectively identified as '*rastellata*' (sensu lato), with their taxonomy presently under review. However, *P. tuberosa* can be easily separated from *P. rastellata* by its high, strongly convex mesosoma with the anterior face of the pronotum ascending towards its summit in an almost straight line. In contrast the outline of the mesosoma in *P. rastellata* is lower and more uniformly rounded with the anterior face of the pronotal dorsum distinctly convex. Also, the pronotal humeri in *P. tuberosa* are widely rounded, while in *P. rastellata* the humeri are subangular with the greatest width of the pronotal dorsum across, or just behind the shoulders. The legs in *P. tuberosa* are quite dark reddish-brown, or almost black, while in *P. rastellata* the legs are very light red or orange.

Polyrhachis wagneri Viehmeyer, 1914

Polyrhachis wagneri Viehmeyer, 1914: 51, fig. 10. Holotype worker. Type locality: NEW GUINEA, Wareo, MNHU (examined).

Polyrhachis (Cyrtomyrma) wagneri Viehmeyer. Emery, 1925: 208; Donisthorpe, 1938: 263.

REMARKS. *Polyrhachis wagneri* is relatively similar to *P. leonidas* from the Bismarck Archipelago from which it differs by a distinctly smaller head, higher and more convex pronotum and very short, tooth-like propodeal spines. The petiole is exceptionally broad with widely diverging lateral spines. *Polyrhachis wagneri* appears to be rare, with only one recent specimen, collected by RWT at Yawasora nr Wewak (East Sepik Province, Papua New Guinea), available for examination. Although Viehmeyer listed only one specimen in the original description, there are four specimens in the MNHU labelled as types.

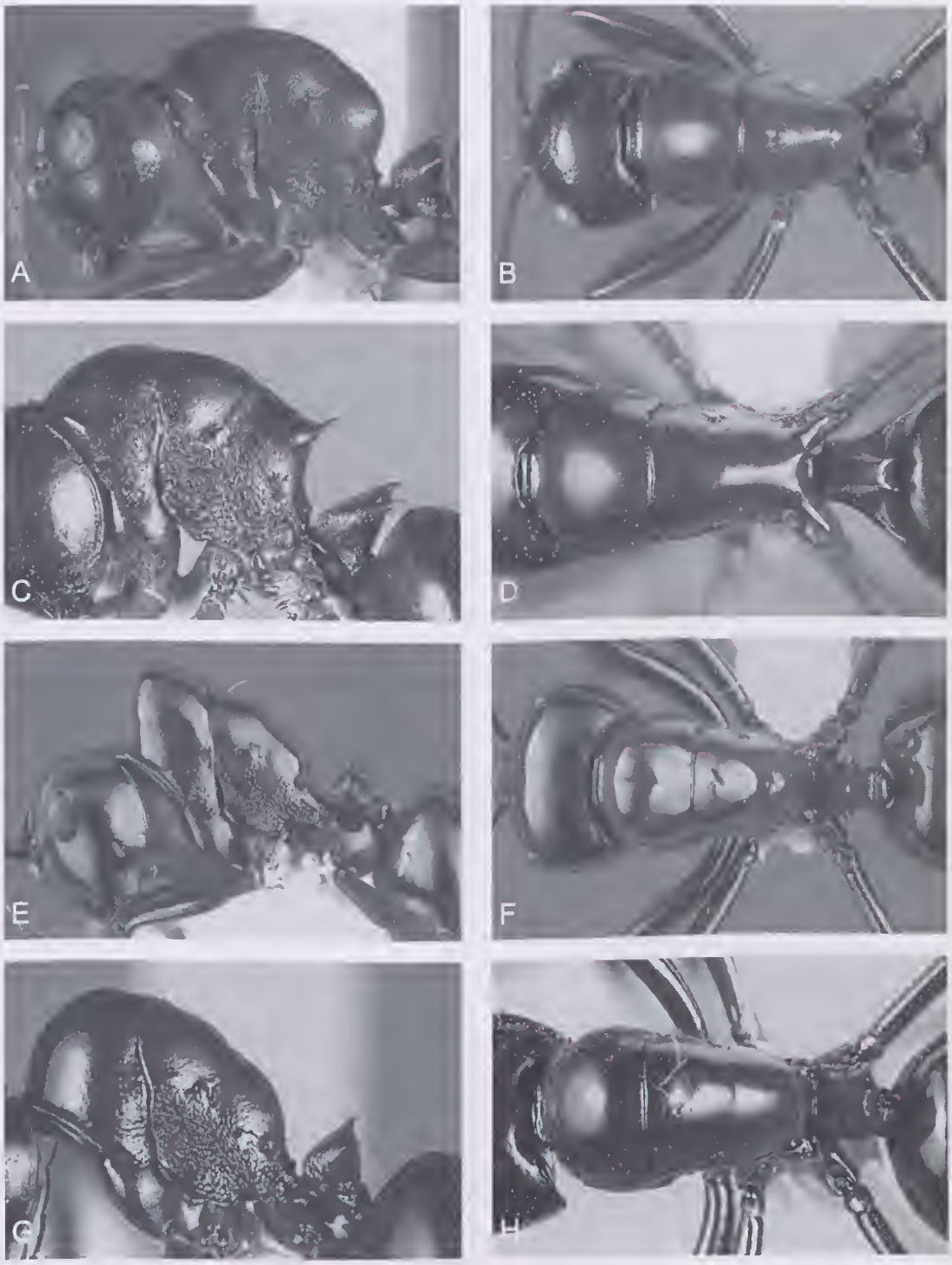


FIG. 8. *Polyrhachis (Cyrtomyrma)* species from New Guinea, Lateral view of mesosoma and petiole (left); dorsal view of mesosoma and petiole (right). A-B, *P. aporema* sp. nov.; C-D, *P. barryi* sp. nov.; E-F, *P. conspicua* sp. nov.; G-H, *P. dorsena* sp. nov.

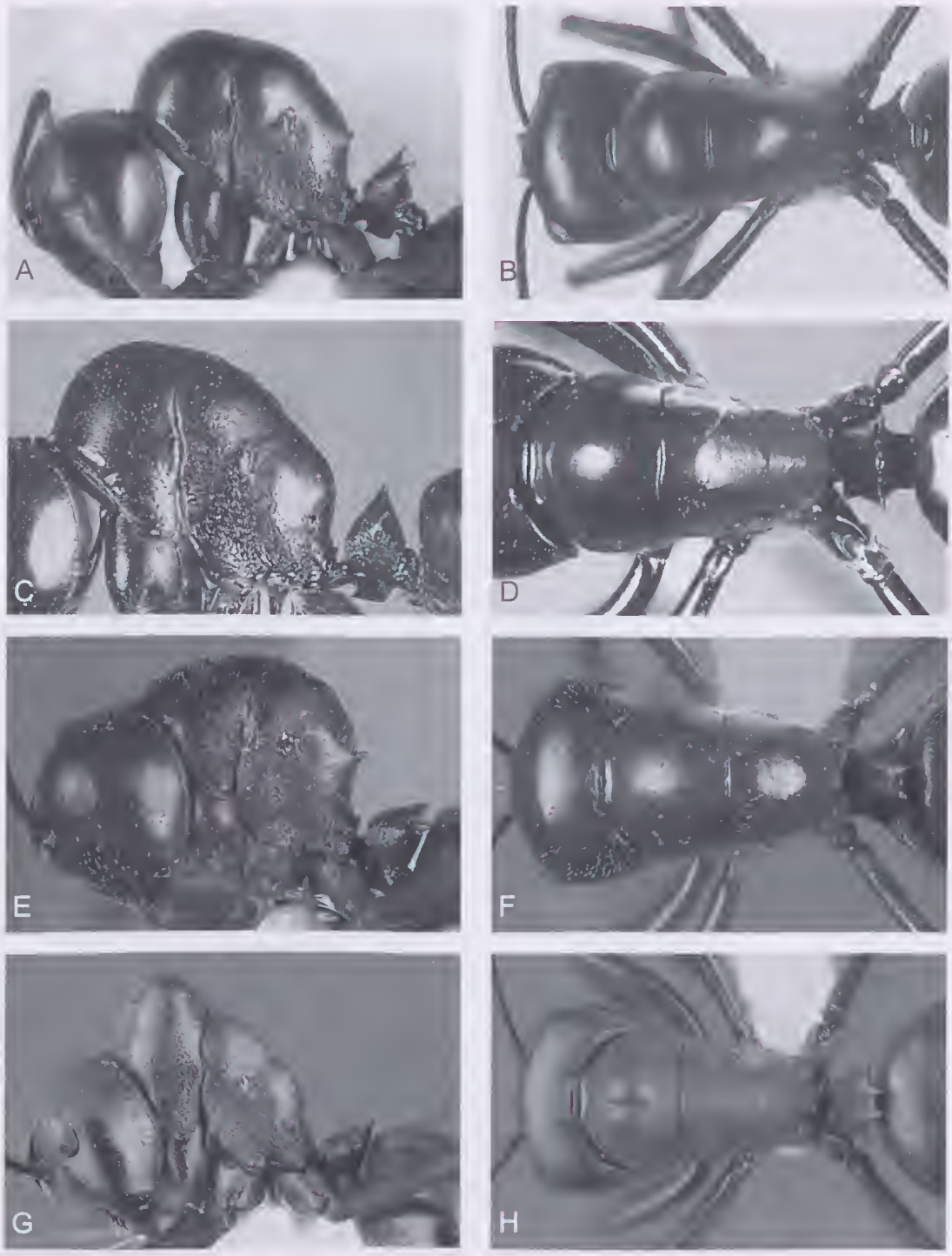


FIG. 9. *Polyrhachis (Cyrtomyrma)* species from Seram Island and New Guinea, Lateral view of mesosoma and petiole (left); dorsal view of mesosoma and petiole (right). A-B, *P. goramensis* Emery; C-D, *P. hybosa* sp. nov.; E-F, *P. inducta* sp. nov.; G-H, *P. inflata* sp. nov.

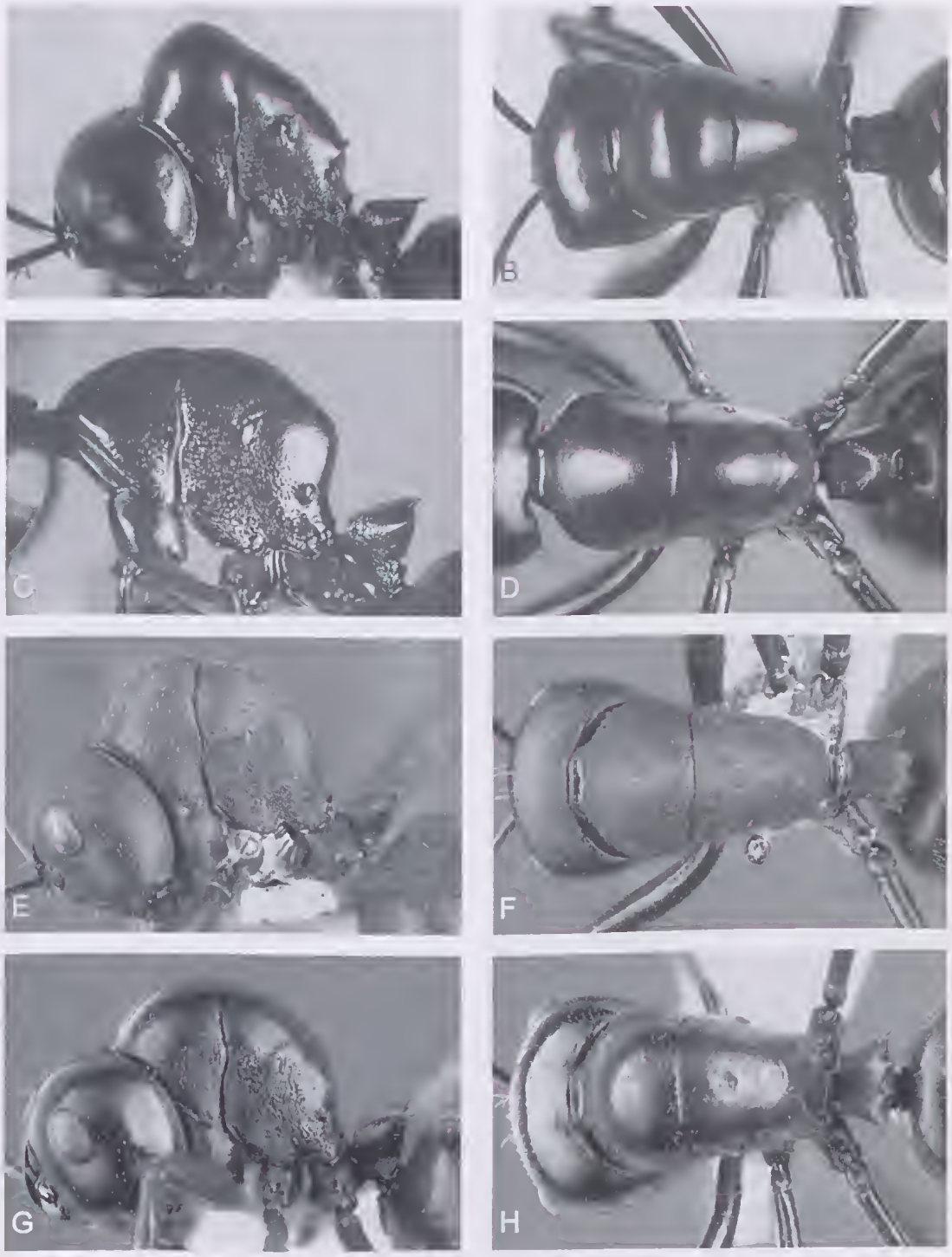


FIG. 10. *Polyrhachis (Cyrtomyrma)* speeies from New Guinea, Lateral view of mesosoma and petiole (left); dorsal view of mesosoma and petiole (right). A-B, *P. integra* sp. nov.; C-D, *P. kyawthani* sp. nov.; E-F, *P. luctuosa* Emery; G-H, *P. nomo* Donisthorpe.

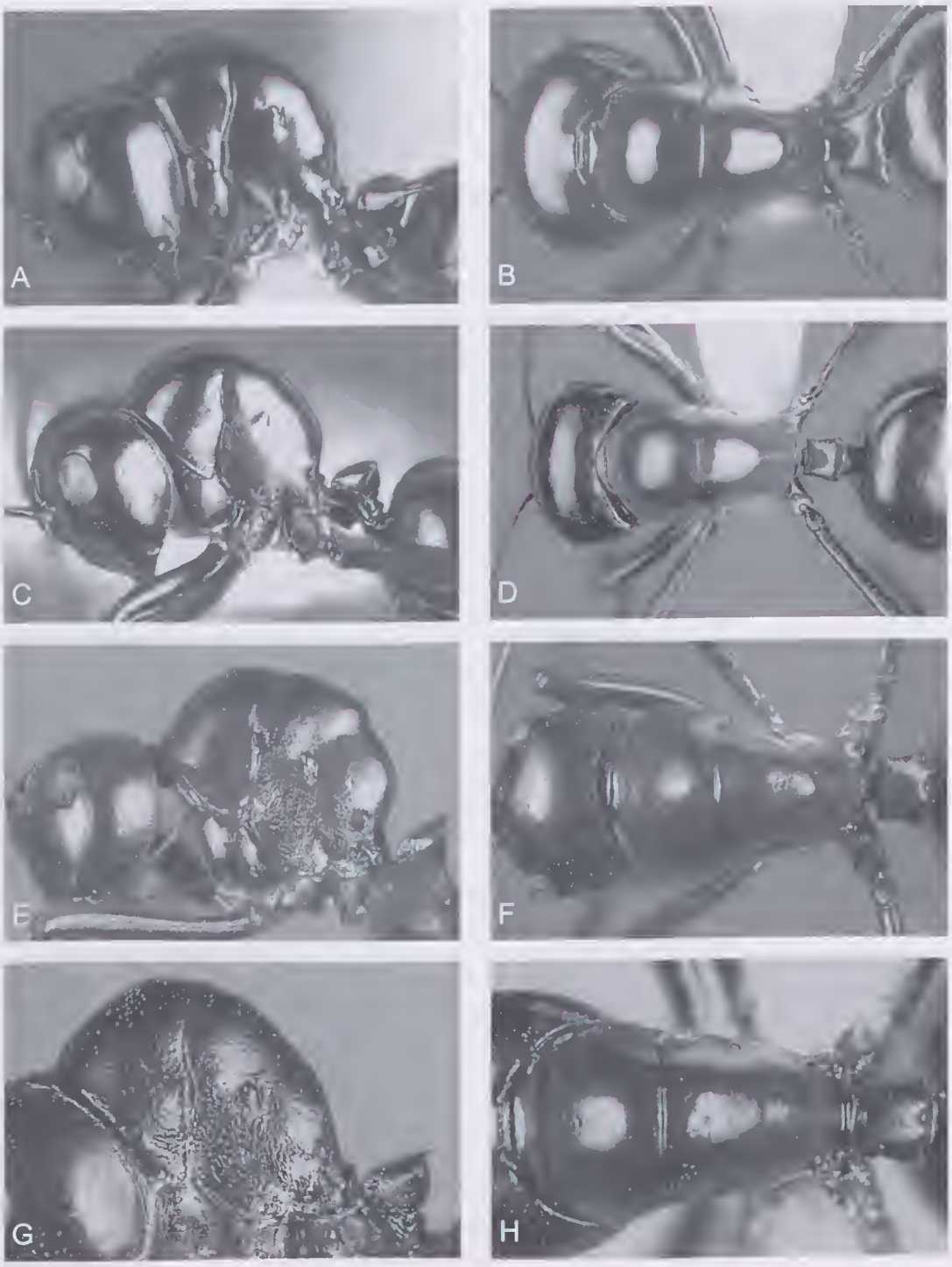


FIG.11. *Polyrhachis (Cyrtomyrma)* species from New Guinea and the Philippines, Lateral view of mesosoma and petiole (left); dorsal view of mesosoma and petiole (right). A-B, *P. sedlaceki* sp. nov.; C-D, *P. semiinermis* Donisthorpe; E-F, *P. strumosa* sp. nov.; G-H, *P. tuberosa* sp. nov.

CHECKLIST OF *CYRTOMYRMA* SPECIES FROM THE SOLOMON ISLANDS

P. emeryana Mann
P. fulakora Mann
P. johnsoni Mann
P. pacifica sp. nov.
P. setosa sp. nov.
P. ugiensis Mann
P. undulata sp. nov.

Mann (1919) described *Polyrhachis (Cyrtomyrma) johnsoni*, *P. fulakora* and *P. ugiensis* as subspecies (varieties) of *P. rastellata* (Latreille). Donisthorpe (1938) raised *P. ugiensis* to specific status and I also consider *P. johnsoni* to be a 'good' species. Despite the status of *P. fulakora* being unresolved, I do not consider it a synonym of *P. rastellata* and have also elevated it to species level. Because all available species-group names have identical status according the the code, regardless of their rank, assigning of species status to the names of unresolved taxa seems a reasonable course to follow.

KEY TO *CYRTOMYRMA* SPECIES FROM THE SOLOMONS (BASED ON WORKER CASTE)

1. Dorsum of mesosoma more-or-less evenly convex in outline 2

   Dorsum of mesosoma distinctly higher anteriorly, descending posteriorly in uneven, undulating outline (Fig. 12A, C, E, G) 4

2. Propodeal dorsum with pair of small teeth or tubercles; propodeal declivity very steep, virtually vertical, weakly concave at base ..... *johnsoni* Mann

   Propodeal dorsum without teeth or tubercles; propodeal declivity oblique to main axis of body 3

3. Generally larger species (HL >1.68); petiole with well developed, acute, subequal spines .... *fulakora* Mann

   Generally smaller species (HL <1.53); petiole rather narrow, almost parallel-sided, with short, tooth-like spines ..... *ugiensis* Mann

4. Pronotal humeri distinctly angular or subangular (Fig. 12D, H) 5

   Pronotal humeri widely rounded (Fig. 12B, F) 6

5. Propodeum with pair of acute spines; mesosoma in profile with pronotal dorsum distinctly higher than summit of mesonotum (Fig. 12C) ..... *pacifica* sp. nov.

   Propodeum without spines; mesosoma in profile with summit of mesonotum distinctly higher than pronotal dorsum (Fig. 12G) ..... *undulata* sp. nov.

6. Promesonotal suture situated at bottom of deep impression (Fig. 12A); propodeum with short, acute, upturned spines (Fig. 12A); whole body with abundant, closely appressed hairs ..... *emeryana* Mann

   Promesonotal suture not within impression (Fig. 12E); propodeum unarmed or, at most, with pair of very short spines or tubereulae; whole body covered with very abundant, short, erect, bristle-like hairs and rather short, decumbent hairs (Fig. 12E) .... *setosa* sp. nov.

Polyrhachis emeryana Mann, 1919 (Fig. 12A-B)

Polyrhachis (Cyrtomyrma) emeryana Mann, 1919: 390, fig. 59; Emery, 1925: 207; Donisthorpe, 1938: 263. Holotype worker. Type locality: SOLOMON IS, Malaita, Auki (W.M. Mann) (location of type unknown).

REMARKS. *Polyrhachis emeryana* is very similar to *P. expressa* from Cape York Peninsula, described above, with distinguishing characters listed under the latter. In lieu of the apparently misplaced holotype, my concept of the species is based on a voucher specimen (BMNH) evidently compared with the holotype by Than (1978), and a few additional specimens collected by P. Greenslade at Mt Austen (Guadalcanal, Solomon Is) (ANIC, QM). *Polyrhachis emeryana* appears to be rare and restricted to the Solomons.

Polyrhachis fulakora Mann, 1919 stat. nov.

Polyrhachis (Cyrtomyrma) rastellata var. *fulakora* Mann, 1919: 389; Emery, 1925: 208; Donisthorpe, 1938: 257. Syntype workers. Type locality: SOLOMON IS, Ysabel I., Fulakora (W.M. Mann), MCZC, NMNH, QM (examined).

REMARKS. Although described as a variety of *P. rastellata*, *P. fulakora* is most similar to *P. ugiensis* Mann, also from the Solomons. I have directly compared numerous syntypes of both species and believe that they represent separate, although very similar, species. In outline, the pronotal dorsum of *P. ugiensis* is much more convex, especially anteriorly, where it rises from the pronotal collar almost vertically for a short distance and then continues in a convex outline to the promesonotal suture. In contrast, the pronotal dorsum in *P. fulakora* is only weakly convex from the pronotal collar to the promesonotal suture. Also, the lateral petiolar spines in *P. ugiensis* are greatly reduced, while the petiolar spines in *P. fulakora* are more-or-less subequal. Both species differ from the closely allied *P. johnsoni* Mann in having the greatest width of the pronotal dorsum at, or about, the middle of its length. In *P. johnsoni* the greatest width of the pronotal dorsum is across, or just below the humeri. *Polyrhachis fulakora* appears to be endemic to the Solomon Islands.

Polyrhachis johnsoni Mann, 1919 stat. nov.

Polyrhachis (Cyrtomyrma) rastellata var. *johnsoni* Mann, 1919: 390; Emery, 1925: 208. Syntype workers. Type locality: SOLOMON IS., Rendova (W.M. Mann) MCZC, NMNH, BMNH (examined).

Polyrhachis (Cyrtomyrma) debilis var. *johnsoni* Mann. Donisthorpe, 1938: 266.

REMARKS. *Polyrhachis johnsoni* was originally described as a variety of *P. rastellata*, but was treated by Donisthorpe (1838) as a variety of *P. debilis*. *Polyrhachis johnsoni* is certainly more closely related to *P. debilis* than to *P. rastellata* but can be easily distinguished from both by the outline of pronotum. In *P. johnsoni* the pronotal dorsum is rather flat, while it is distinctly convex in the other two species. From *P. rastellata* it also differs by the presence of distinct, though short, propodeal spines or tubercles. From *P. debilis* it differs primarily by its distinctly larger size (HL 1.72-1.87 in *P. johnsoni* syntypes versus 1.34-1.47 in *P. debilis* syntypes) and by the propodeal declivity that is almost as high as the full height of the petiole. In *P. debilis* the propodeal declivity is relatively low, with its dorsal margin barely reaching the level of the bases of the dorsal petiolar teeth. The known distribution of *P. johnsoni* appears to be limited the Solomon Islands, but there are a few unconfirmed records from the East Britain Province of Papua New Guinea. Due to the uncertain nature of these records, *P. johnstoni* has not been included in the checklist and key to the New Guinean species of *Cyrtomyrma*.

Polyrhachis pacifica sp. nov.
(Fig. 12C-D)

MATERIAL. HOLOTYPE: SOLOMON IS, GUADALCANAL, Gold Ridge, 800m, 23.vi.1956, J.L. Gressitt (worker). PARATYPE: BOUGAINVILLE (S), Guaba, 720m, 19.vi.1956, E.J. Ford Jr. (worker). Type deposition: Holotype in MCZC; paratype in BMNH.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 5.09, 4.94; HL 1.34, 1.28; HW 1.31, 1.28; CI 98, 99; SL 1.50, 1.43; SI 114, 112; PW 1.15, 1.03; MTL 1.72, 1.62 (2 measured).

Clypeus in profile straight, narrowly rounding into impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate with weakly raised margins; central area rather flat with short frontal furrow. Sides of head in front of eyes weakly convex, converging towards mandibular bases; behind eyes sides rounding into moderately convex occipital margin. Eyes moderately convex, in full face view just reaching lateral cephalic outline. Ocelli lacking. Pronotum in dorsal view widest across distinctly angular humeri. Mesosoma in profile with pronotal dorsum strongly convex; mesosoma posteriorly descending from summit of pronotum in rather uneven outline, weakly impressed at promesonotal suture and distinctly stepped at metanotal groove; propodeal dorsum descending abruptly into steep, very weakly concave declivity; propodeum armed with pair of slender, acute, upturned, dorso-laterally directed spines. Petiole with anterior face straight, posterior face convex; dorsum armed with four acute spines, lateral pair distinctly more slender and almost twice as long as dorsal pair. Anterior face of first gastral segment lower than total height of petiole, base very weakly concave.

Mandibles very finely rugose with numerous piliferous pits. Head, mesosoma and gaster shagreened with numerous shallow punctures. Intensity of sculpturation increasing only marginally towards sides of pronotum and lateral portions of mesosoma, with meso- and metapleurae somewhat irregularly reticulate. Petiole with both faces finely transversely wrinkled.

Mandibles near masticatory borders with only a few, semierect, short hairs. Anterior clypeal margin with 3 relatively long, anteriorly directed setae and 4 erect hairs arising just behind anterior margin. A few medium length hairs on extreme apex and ventral surfaces of apical gastral segments. Rest of body virtually hairless, except for numerous microscopic decumbent hairs arising from shallow pits.

Colour. Black; mandibular masticatory borders, condylae, extreme tips of apical funicular segments, distal ends of trochanters, most of tibiae and gastral apex, light to medium reddish-brown. Rest of legs, including tarsi, distinctly darker.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis pacifica* is known only from the two collection localities of the types and nothing is known about its nesting habits. *Polyrhachis pacifica* is somewhat similar to *P. emeryana*. They share the highly convex pronotum with the mesonotum and propodeum descending posteriorly in an uneven, stepped outline. They differ in the shape of the pronotal humeri that, in *P. pacifica* are distinctly angular, while they are widely rounded in *P. emeryana*. *Polyrhachis undulata*, described below, is also similar, sharing the unevenly descending mesosomal profile. It differs from *P. pacifica* by a complete lack of propodeal spines and from *P. emeryana* by distinctly angular pronotal humeri.

Polyrhachis undulata also differs from both by its larger size (HL 1.53-1.59 in *P. undulata* versus 1.28-1.34 in *P. pacifica* and 1.34-1.40 in *P. emeryana*) and in having the mesonotal dorsum distinctly higher than the pronotum. In *P. pacifica* and *P. emeryana* the summit of the pronotal dorsum is the highest point of mesosoma.

Polyrhachis setosa sp. nov.
(Fig. 12E-F)

MATERIAL. HOLOTYPE: SOLOMON IS, GUADALCANAL, Mt Austen, 09°29'S, 159°59'E, 13.x.1965, P.J.M. Greenslade acc. 29691 (worker). PARATYPES: data as for holotype (4 workers); ditto, Mt Austen Rd, 11.ii.1965, P.J.M. Greenslade acc. 15721 (dealate ♀). Type deposition: Holotype worker and paratype ♀ in ANIC; 1 paratype worker each in BMNH, MCZC and QM.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 4.89, 4.89-5.09; HL 1.28, 1.28-1.34; HW 1.25, 1.25-1.31; CI 98, 98; SL 1.50, 1.43-1.56; SI 120, 114-120; PW 0.94, 0.94-0.97; MTL 1.78, 1.72-1.84 (4 measured).

Apical mandibular tooth long, other teeth shorter and subequal. Anterior clypeal margin with central flange irregularly serrated. Clypeus in profile straight anteriorly, posteriorly rounding into well impressed basal margin. Frontal triangle indistinct. Frontal carinae sinuate with very weakly raised margins; central area rather flat with short, weakly indicated frontal furrow. Sides of head in front of eyes convex, rather strongly converging towards mandibular bases; behind eyes sides widely rounding into convex occipital margin. Eyes weakly convex, in full face view not, or just, reaching lateral cephalic outline. Ocelli lacking. Pronotum in dorsal view with humeri narrowly rounded or very weakly angular in some specimens; greatest width of pronotum across or just behind shoulders. Mesosoma in profile with moderately convex pronotum; promesonotal suture rather distinct; mesonotal dorsum weakly convex; metanotal groove indicated by shallow depression in outline; propodeal dorsum flat with pair of rather indistinct spines or tubercules; propodeal declivity virtually vertical. Petiole with anterior face straight, posterior face convex; dorsum armed with four short spines of subequal length; dorsal pair broad-based, more tooth-like; lateral pair distinctly more slender. Subpetiolar process almost as wide as long with anterior angle acute, narrowly rounded posteriorly. Anterior face of first gastral segment very weakly concave at base.

Mandibles finely rugose with numerous piliferous pits. Head, mesosoma and gaster shagreened with numerous punctures; sculpturation somewhat more intense laterally with meso- and metapleurae distinctly reticulate-rugose.

Mandibles with numerous, short, mostly decumbent hairs at mandibular bases; longer, semierect hairs arising near masticatory borders. Virtually all body surfaces, including antennal scapes and legs, with numerous erect, bristle-like hairs and rather short, decumbent hairs arising from abundant punctures and pits.

Colour. Black; mandibles, condylae, distal half of apical funicular segments and trochanters light to medium reddish-brown. Antennal scapes dark brown, progressively lighter towards apex, including funiculi. Legs generally medium to dark reddish-brown; tarsi black. Gaster ventrally very dark reddish-brown.

Queen. Dimensions: TL c. 5.90; HL 1.40; HW 1.28; CI 91; SL 1.68; SI 131; PW 1.34; MTL 2.09 (1 measured). Apart from sexual characters, similar to worker except: pronotal humeri rounded; mesoscutum almost as long as wide with lateral margins converging anteriorly, forming evenly rounded anterior margin; median line weakly indicated; parapsides flat anteriorly, weakly raised posteriorly; mesoscutum in profile with rounded anterior face and very weakly convex dorsum. Mesoscutellum distinctly more convex, moderately raised above dorsal plane of mesosoma; metanotal groove distinct. Propodeum with pair of distinct teeth; dorsum convex in outline, medially rounding into virtually vertical declivity in uninterrupted curve. Petiole relatively narrow, parallel-sided in dorsal view, armed with four, subequal teeth. Other characters virtually identical to those of worker.

Male and immature stages unknown.

REMARKS. *Polyrhachis setosa* is known only from the type locality and its nesting habits are unknown. In many aspects *P. setosa* is similar to *P. decumbens*, from Australia, described above. They differ in the form of their pubescence which in *P. setosa* is mostly erect and bristle-like, while it is shorter and mostly decumbent in *P. decumbens*. Additionally, in *P. setosa* the eyes in full face view do not or only just reach the lateral cephalic outline, while in *P. decumbens* they clearly break the outline of the head.

Polyrhachis ugiensis Mann, 1919

Polyrhachis (Cyrtomyrma) rastellata subsp. *ugiensis* Mann, 1919: 389; Emery, 1925: 208. Syntype workers. Original localities: SOLOMON IS, Ugi, Pawa; San Cristoval, Waiai, Pamua, Wainoni Bay; Three Sisters, Malapaina (W.M. Mann), MCZC, MLAC, QM,USNM (examined).

Polyrhachis (Cyrtomyrma) ugiensis Mann. Donisthorpe, 1938: 260. Raised to species.

REMARKS. *Polyrhachis ugiensis* was raised to species level by Donisthorpe (1938) and following the examination of numerous syntypes and additional specimens, I agree with his decision. *Polyrhachis ugiensis* is rather similar to *P. fulakora* with distinguishing characters listed under the latter.

Polyrhachis undulata sp. nov.
(Fig. 12G-H)

MATERIAL. HOLOTYPE: SOLOMON IS, Guadalcanal, Mt Austen, 09°29'S, 159°59'E, 13.xi.1964, P.J.M. Greenslade #15093 (worker). PARATYPES: data as for holotype (1 worker); data as for holotype, except 21.iv.1965, P.J.M. Greenslade #16888 (3 workers). Type deposition: Holotype and 1 paratype in ANIC, 1 paratype each in BMNH, MCZC and QM.

DESCRIPTION. *Worker*. Dimensions (holotype cited first): TL c. 6.30, 6.00-6.35; HL 1.59, 1.53-1.59; HW 1.50, 1.43-1.50; CI 94, 92-94; SL 1.72, 1.59-1.72; SI 115, 111-117; PW 1.25, 1.12-1.25; MTL 2.09, 2.00-2.09 (3 measured).

Clypeus in profile very weakly, evenly convex with weakly and narrowly impressed basal margin, indicated laterally by distinct line. Frontal triangle weakly impressed. Frontal carinae sinuate with weakly raised margins; central area weakly concave medially with rather faint frontal furrow. Sides of head in front of eyes straight, converging towards mandibular bases; behind eyes sides rounding into moderately convex occipital margin. Eyes moderately convex, in full face view just reaching or, at most, only marginally breaking lateral cephalic outline. Ocelli lacking; relative position of median ocellus indicated by small pit in cephalic sculpture. Pronotum in dorsal view with humeri obtusely angular. Mesosoma in profile with pronotal dorsum convex; promesonotal suture distinctly impressed; mesonotal dorsum convex, elevated above pronotum; metanotal groove indistinct dorsally, laterally evident as very short furrow; propodeum descending posteriorly in stepped outline, armed with pair of more-or-less distinct tuberculae; declivity very steep. Petiole with anterior face straight, posterior face weakly convex; dorsum armed with four acute spines, lateral pair slightly longer and more slender than dorsal pair. Subpetiolar process angulate anteriorly, widely rounded posteriorly. Anterior face of first gastral segment straight, narrowly rounding onto dorsum of segment.

Mandibles very finely rugose with numerous piliferous pits. Head, mesosoma and gaster shagreened with sides of pronotum and meso- and metapleurae reticulate to reticulate-rugose.

Mandibles with numerous semierect hairs at masticatory borders and very short appressed hairs arising from pits towards mandibular bases. A few long, anteriorly directed setae on clypeal margin medially and a few very short setae laterally. Two pairs of erect hairs arising near anterior clypeal margin; single pair of medium length, somewhat curved hairs on summit of mesonotum. Gaster with short to medium length, erect hairs lining posterior margins of apical segments, more numerous on ventral surfaces. Whole body densely covered with very short, appressed hairs arising from shallow punctures and pits.

Colour. Black, including proximal half of antennal scapes, coxae and tarsi. Mandibles, condylae, distal half of antennal scapes, funiculi, trochanters, femora, tibiae and apex of gaster dark to very dark reddish-brown. Mandibular masticatory borders and tips of apical funicular segments a shade lighter.

Sexuals and immature stages unknown.

REMARKS. *Polyrhachis undulata* is another species endemic to the Solomon Islands and is known only from the type locality. Nothing is known about its nesting habits. It is relatively similar to *P. emeryana* and *P. pacifica* with distinguishing characters listed under *P. pacifica*.

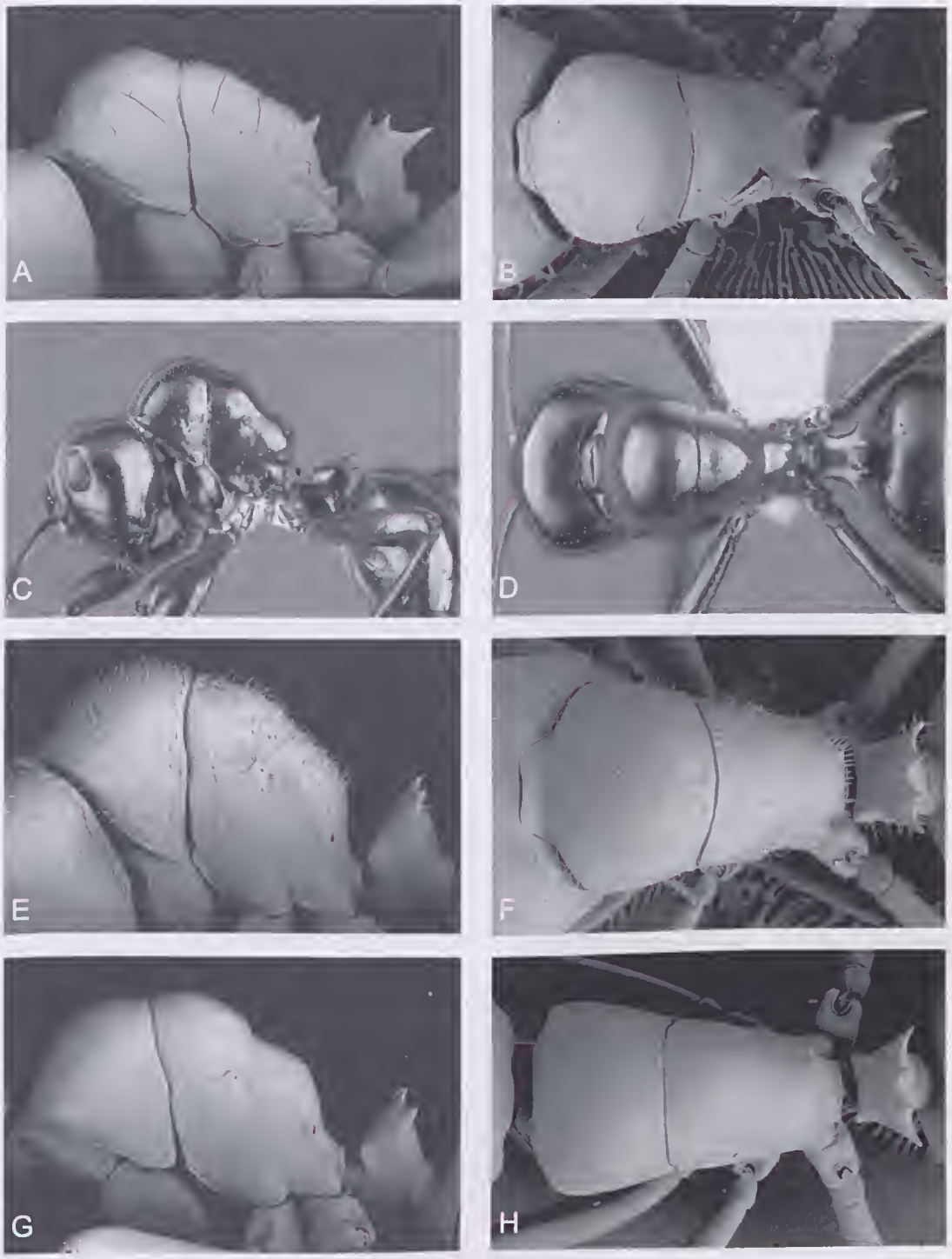


FIG.12. *Polyrhachis (Cyrtomyrma)* species from the Solomon Islands, Lateral view of mesosoma and petiole (left); dorsal view of mesosoma and petiole (right). A-B, *P. emeryana* Mann; C-D, *P. pacifica* sp. nov.; E-F, *P. setosa* sp. nov.; G-H, *P. undulata* sp. nov.

ACKNOWLEDGEMENTS

I am very grateful to the Australian Biologieal Resourees Study and the Australian Researeh Counеil for grants supporting my work on the systematies of Australian *Polyrhachis* ants. This work was also generously supported by two Ernst Mayr Grants that allowed me to study speeimens in the Museum of Comparative Zoology, Harvard University. I also thank Simon Robson of James Cook University, Townsville for a steady supply of *Cyrtomyrma* material from north Queensland's tropies. My sineere thanks go to Prof. Datin Dr Maryati Mohamed, Institute for Tropieal Biology and Conservation, Universiti Malaysia Sabah, for her finaneial and logistie support during my visits to Sabah, Borneo. I am also grateful to Drs Steve O. Shattuck, Robert W. Taylor (both ANIC) and Dr Stefan P. Cover (MCZC), for unlimited aeeess to the eolleetions in their eare. Sineere thanks to Dr Barry Bolton and Miss Christine Taylor (BMNH), Dr Ted R. Sehultz (NMNH), Dr James M. Carpenter (AMNH), Dr Brian L. Fisher (CASC), Dr Chris O'Toole (OXUM), Dr R.R. Snelling (MLAC), Dr P.C. Ward (UCDC) and Dr Ing. C. (Kees) van Aehterberg (NNML), for their kindness in providing loans of types and other speeimens. For loans and gifts of numerous speeimens my sineere thanks also go to Prof. Seiki Yamane, Kagoshima University, Japan, Rev. Sr Karmaly K.A., Calieut University, India and Dr Himender Bharti, Punjabi University, Patiala, India. Speeial thanks are due to Dr Gary D. Alpert, Harvard University, Cambridge, for his hospitality during my visits to the MCZC. Thanks to my colleagues, Drs Chris Burwell and Geoff Monteith (both QM), for their valuable support during the eourse of this study. I must thank Susan Wright (QM) and Natalie Barnett (ANIC) for their patienee and eare in preparation of the SEM miereographs and digital images. I would also like to extend my gratitude to the Environmental Proteetion Ageney and Department of Natural Resourees for permits to allow eolleeting in Queensland's National Parks and State Forests. Finally, thankyou to Chris Burwell (QM) for reading and eommenting on a draft of the manuseript.

LITERATURE CITED

BELLAS, T. & HÖLLDOBLER, B. 1985. Constituents of mandibular and Dufour's glands of an Australian *Polyrhachis* weaver ant. Journal of Chemieal Ecology 11: 525-538.

BINGHAM, C.T. 1903. The fauna of British India, ineluding Ceylon and Burma. Hymenoptera 2. Ants and Cuckoo-Wasps: 506 p. London.

BOLTON, B. 1995. A new general Catalogue of the Ants of the World. (Harvard University Press: Cambridge, Mass.).

DALLA TORRE, C.G.de 1893. Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus 7: 289 pp. Lipsiae.

DONISTHORPE, H. 1932. On the identity of Smith's types of Formicidae (Hymenoptera) collected by Alfred Russell Wallace in the Malay Archipelago, with deseriptions of two new speeies. Annals and Magazine of Natural History (10)10: 441-476.

1938. The subgenus *Cyrtomyrma* Forel of *Polyrhachis* Smith, with deseriptions of new speeies, etc. Annals and Magazine of Natural History (11)1: 246-267.

1941. Deseriptions of new ants (Hym., Formicidae) from various localities. Annals and Magazine of Natural History (11)8: 199-210.

DOROW, W.H.O. 1995. Revision of the ant genus *Polyrhachis* Smith, 1857 (Hymenoptera: Formicidae: Formicinae) on subgenus level with keys, eheeklist of speeies and bibliography. Courier Forsehungsinstitut Senekenberg 185: 1-113.

DRURY, D. 1773. Illustrations of Natural History. Wherein are exhibited upwards of two hundred and twenty figures of exotie insects 2. 90 pp. London.

EMERY, E. 1887. Catalogo delle formiche esistenti nelle collezioni del Museo Civieo di Genova. Parte terza. Formiche della regione Indo-Malese e dell' Australia. Annali del Museo Civieo di Storia Naturale di Genova 4(2): 209-258.

1896. Saggio di un catalogo dei generi *Camponotus*, *Polyrhachis* e affini. Memorie della R. Accademia delle Seienze dell'Istituto di Bologna (5)5: 363-382 (pp. 761-780 in separate).

1900. Formiche raccolte da Elio Modigliani in Sumatra, Engano e Mentawei. Annali del Museo Civieo di Storia Naturale di Genova (2)20[40]: 661-722.

1921. Le genre *Polyrhachis*. Classification; espèees nouvelles ou eritiques. Bulletin de la Société Vaudoise des Sciences Naturelles 54: 17-25.

1925. In Wytsman, Genera Insectorum. Hymenoptera, Fam. Formicidae, subfam. Formicinae. Fasc. 183. Bruxelles.

FOREL, A. 1893. Les formicides de l'Empire des Indes et de Ceylan. Part 3. Journal of the Bombay Natural History Society 8: 17-36.

1901. Formiciden aus dem Bismarek-Archipel, auf Grundlage des von Prof. Dr. F. Dahl gesammelten Material bearbeitet. Mitteilungen aus dem Zoologisehen Museum in Berlin 2: 1-38.

1902. Fourmis nouvelles d'Australie. Revue Suisse de Zoologie 10: 405-548.

1915. Results of Dr. E. Mjöberg's Swedish scientific expeditions to Australia, 1910-1913. 2. Ameisen.

Arkiv för Zoologi 9(16): 1-119.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1999. *International Code of Zoological Nomenclature* (Fourth Edition). London: 306p.

KARAWAJEW, W. 1927. Ameisen aus dem Indo-Australischen Gebiet III. Académie des Sciences de l'Ukraïne. Memoires de la Classe des Sciences Physiques et Mathématiques 7(1). Travaux du Musée Zoologique 3: 3-52. Kiev.

KOHOUT, R.J. 1990. A review of the *Polyrhachis viehmeyeri* species-group. Memoirs of the Queensland Museum 28: 499-508.

1998. New synonyms and nomenclatural changes in the ant genus *Polyrhachis* Fr. Smith (Hymenoptera: Formicidae: Formicinae). Memoirs of the Queensland Museum 42: 505-531.

1999. Australian *Polyrhachis* and their nesting habits (Formicidae: Formicinae). Proceedings of the International Colloquia on Social Insects. V.E. Kipyatkov (ed.). Russian Language Section of the IUSSI. Socium. St. Petersburg. 1997. vol. 3-4, Pp 217-222.

2000. A review of the distribution of the *Polyrhachis* and *Echinopla* ants of the Queensland Wet Tropics (Hymenoptera: Formicidae: Formicinae). Memoirs of the Queensland Museum 46: 183-209.

KOHOUT, R.J. & TAYLOR, R.W. 1990. Notes on Australian ants of the genus *Polyrhachis* Fr. Smith, with a synonymic list of the species (Hymenoptera: Formicidae: Formicinae). Memoirs of the Queensland Museum 28: 509-522.

LATREILLE, P.A. 1802. Histoire Naturelle des Fourmis, et recueil de mémoires et d'observations sur les abeilles, les araignées, les faucheurs, et autres insectes. Paris.

MANN, W.M. 1919. The ants of the British Solomon Islands. Bulletin of the Museum of Comparative Zoology at Harvard College 63: 273-391.

MAYR, G. 1862. Myrmecologische Studien. Verhandlungen der k.k. Zoologisch-Botanischen Gesellschaft in Wien 12: 649-776.

1867. Adnotationes in monographiam formicidarum Indo-Neerlandicarum. Tijdschrift voor Entomologie (2) 2 [10]: 33-117, pl. 2.

1870. Neue Formiciden. Verhandlungen der k.k. Zoologisch-Botanischen Gesellschaft in Wien 20: 939-996.

1872. Formicidae Borneenses collectae a J. Doria et O. Beccari in territorio Sarawak annis 1865-1867. Annali del Museo Civico di Storia Naturale di Genova 2: 133-155.

1876. The Australischen Formiciden. Journal des Museum Godefroy (4)12: 56-115.

1879. Beiträge zur Ameisen-Fauna Asiens. Verhandlungen der k.k. Zoologisch-Botanischen Gesellschaft in Wien 28: 645-686.

ROBSON, S.K.A. & KOHOUT, R.J. 2005. Evolution of nest-weaving behaviour in arboreal nesting ants of the genus *Polyrhachis* Fr. Smith (Hymenoptera: Formicidae). Australian Journal of Entomology 44: 164-169.

ROGER, J. 1863. Verzeichniss der Formiciden-Gattungen und Arten. Berliner Entomologische Zeitschrift 7 (Beilage): 1-65.

SANTSCHI, F.1928. Fourmis de Sumatra, récoltées par Mr J.B. Corporaal. Tijdschrift voor Entomologie 71: 119-140.

SHATTUCK, S.O. 1999. Australian ants: their biology and identification. Monographs on Invertebrate Taxonomy, vol. 3. (CSIRO: Collingwood).

SMITH, F. 1857. Catalogue of the hymenopterous insects collected at Sarawak, Borneo; Mount Ophir, Malacca; and at Singapore, by A.R. Wallace. Journal of the Proceedings of the Linnean Society of London, Zoology 2: 42-88.

1858. Catalogue of Hymenopterous Insects in the Collection of the British Museum 6. Formicidae. London.

1859. Catalogue of hymenopterous insects collected by Mr A.R. Wallace at the Islands of Aru and Key. Journal of the Proceedings of the Linnean Society of London, Zoology 3: 132-158.

1863. Catalogue of hymenopterous insects collected by Mr A.R. Wallace in the Islands of Mysol, Ceram, Waigiou, Bouru and Timor. Journal of the Proceedings of the Linnean Society, Zoology 7: 6-48.

TAYLOR, R.W. 1986. The quadrinominal infrasubspecific names of Australian ants (Hymenoptera: Formicidae). General and Applied Entomology 18: 33-37.

1987. A checklist of the ants of Australia, New Caledonia and New Zealand (Hym.: Formicidae). CSIRO Australia. Division of Entomology Report No. 41: 1-92.

TAYLOR, R.W. & BROWN, D.R. 1985. Zoologieal Catalogue of Australia 2. Hymenoptera: Formicoidea, Vespoidea and Sphecoidea. (Australian Government Publishing Service: Canberra).

THAN, K. 1978. A taxonomic revision of the subgenus *Cyrtomyrma* Forel of the ant genus *Polyrhachis* F. Smith (Hymenoptera: Formicidae). Unpubl. PhD thesis, University of London: London.

VIEHMEYER, H. 1912. Ameisen aus Deutsch Neuguinea gesammelt von Dr. O. Schlaginhaufen. Nebst einem Verzeichnisse der papuanischen Arten. Abhandlungen und Berichte des Königl. Zoologischen und Anthropologisch-Ethnographischen Museums zu Dresden 14: 1-26.

1913. Ameisen aus dem Kopal von Celebes. Stettiner Entomologische Zeitung 74: 141-155.

1914. Neue und unvollständig bekannte Ameisen der alten Welt. Archiv für Naturgeschichte 79 (A12) (1913): 24-60.

WHEELER, W.M. 1911. Three formicid names which have been overlooked. Science. New York (N.S.) 33: 858-860.

1919. The Ants of Borneo. Bulletin of the Museum of Comparative Zoology at Harvard College 63: 43-147.

WU, J. & WANG, C. 1995. The Ants of China. (Forestry Publishing House: China).

YAMANE, S. 1997. A list of Bornean ants. In: General flowering of tropical rainforests in Sarawak. Ed. Tamiji Inoue & Abang Abdul Hamid. Center for Ecological Research, Kyoto University. Canopy Biology Program in Sarawak (CBPS): Series II. (Unpubl. Report).

RANGE EXTENSION FOR THE MULGRAVE RIVER GOBY (*GLOSSOGOBIUS* SP.) (PISCES: GOBIIDAE) IN NORTH QUEENSLAND

FREDERIEKE J. KROON AND JEFFREY W. JOHNSON

Kroon, F.J. & Johnson, J.W. 2006 11 10: Range extension for the Mulgrave River Goby (*Glossogobius* sp.) (Pisees: Gobiidae) in North Queensland. *Memoirs of the Qneensland Museum* **52**(1): 147–150. Brisbane. ISSN 0079-8835.

New distributional records for the Mulgrave River Goby, *Glossogobius* sp. 4 (*sensu* Allen et al., 2002) are presented for Saltwater Creek, a coastal catchment in the northern Wet Tropics. The species has previously been recorded from the Russell/Mulgrave basin, and from Hills Creek and Falls Creek, two short streams flowing into the eastern side of Trinity Inlet. Our records increase the known range of this species northward by 70km. The distribution appears disjunct as there are no records of this species in rivers surveyed between Trinity Inlet and Saltwater Creek. Its apparent very restricted distribution has led to conservation listing of this species as: 'Lower Risk – Near Threatened', 'Restricted', or 'Rare'. Our new records indicate a detailed survey of coastal drainages is needed to better understand the distribution and conservation needs of this species. ❐ *Glossogobius, range extension, Saltwater Creek, Wet Tropics.*

F.J. Kroon, CSIRO Sustainable Ecosystems, Tropical Forest Research Centre, PO Box 780, Atherton, Qld 4883, Australia (email frederieke.kroon@csiro.au); J.W. Johnson, Queensland Museum, PO Box 3300, South Brisbane Qld 4101; 29 May 2006.

The North Queensland Wet Tropics World Heritage Area contains 78 (40%) of Australia's 190 freshwater fish species (Pusey & Kennard, 1996). The two most common families are the Melanotaeniidae (rainbowfishes) and Pseudomugilidae (blue-eyes), while Gobiidae (gobies) and Eleotridae (gudgeons) are the two most speciose families recorded in the area (Russell & Hales, 1993, 1997; Russell et al., 1996a, 1996b, 1998, 2000; Pusey & Kennard, 1994, 1996). The area contains at least eight endemic species (Pusey et al. 2004), including *Cairnsichthys rhombosomoides*, *Melanotaenia eachamensis*, *Melanotaenia utcheensis*, *Glossogobius* sp. 4 (*sensu* Allen et al., 2002; Mulgrave River goby), *Schismatogobius* species, *Stiphodon alleni*, *Hephaestus tulliensis*, and *Guyu wujalwujalensis*.

Effective management of this diverse and speciose freshwater fauna requires information of the biological requirements of fish species, including their distribution and abundance. Accurate distribution records are critical to inform scientists and managers about biodiversity in particular rivers and regions, to prevent loss of habitat and reduction of distributional range, and to implement appropriate conservation and rehabilitation actions.

Here, we present new distributional records of *Glossogobius* sp. 4 for Saltwater Creek, a coastal catchment in the northern Wet Tropics near the town of Mossman (Table 1; Fig. 1). *Glossogobius* sp. 4 has previously been recorded from the Russell/Mulgrave basin (Merrick & Schmida, 1984; Allen, 1989; Wager, 1993), and from Hills Creek and Falls Creek, two short streams flowing into the eastern side of Trinity Inlet (Wager, 1993) (Fig. 1). Additional surveys have confirmed the presence of the species in the Mulgrave and Russell rivers (Pusey & Kennard, 1994, 1996; Pusey et al., 1995; Russell et al., 1996a). Johnson (2000) describes the distribution of *Glossogobius* sp. 4 as the 'Russell–Mulgrave R. drainage' (see also Pusey et al., 2004), 'and several creeks near Mossman, Qld'. The species remains undescribed and has been referred to as *Glossogobius* sp. B (Merrick & Schmida, 1984; Allen, 1989; Wager 1993; Pusey & Kennard, 1994, 1996; Pusey et al., 1995; Herbert & Peeters, 1995), *Glossogobius* sp. C (Wager & Jackson 1993), and *Glossogobius* sp. nov. (Australian Society for Fish Biology, 2004). In the Russell/Mulgrave basin, *Glossogobius* sp. 4 occurs in streams ranging from small tributaries to main channels, and is most abundant in shallow rapid, riffle and run habitats; the species has not been recorded at elevations >70 m.a.s.l. (Pusey et al., 2004).

Glossogobius sp. 4 was recorded in Saltwater Creek during surveys in 1995 and 2004 (Table 1; Fig. 1). In 1995, unidentified *Glossogobius* sp. were collected using backpack electrofishing at ten different locations of Saltwater Creek by the Queensland Department of Primary Industries (Russell et al., 1998). Twenty-three individual

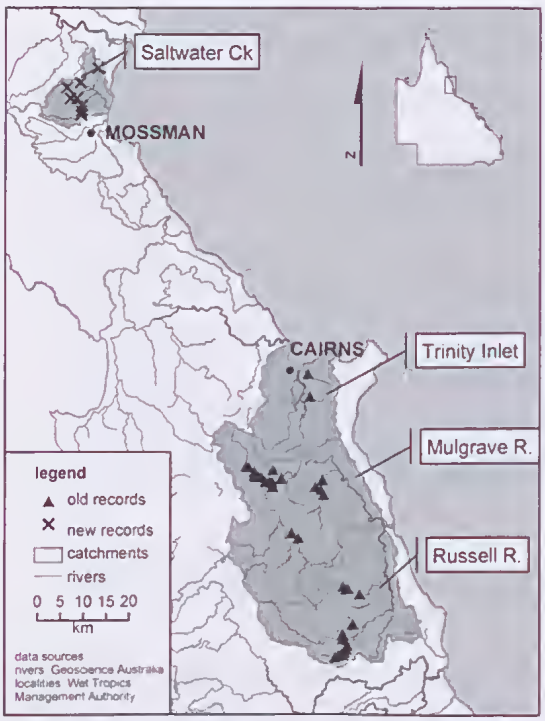


FIG. 1. Distribution map for *Glossogobius* sp. 4 in the northern Wet Tropics in Queensland, Australia, showing previously known records (▲) in the Russell/Mulgrave basin and Trinity Inlet, and new distributional records (×) in Saltwater Creek catchment. Inset map indicates study area location in Queensland.

Glossogobius sp. were lodged with the Queensland Museum and subsequently identified by the second author (J. Johnson) as *Glossogobius* sp. 4. During backpack electrofishing surveys in Saltwater Creek in 2004, 59 additional individuals of *Glossogobius* sp. 4 were collected at three different locations and identified to species level by the senior author (F. Kroon) and Andrew Palmer (CSIRO). Five individuals were lodged with the Queensland Museum for confirmation of species identification; all others were returned alive to the point of capture. Individuals were collected in small tributaries (1995) and the main channel (1995, 2004) in the freshwater section of Saltwater Creek in habitats similar to those described in Pusey et al. (2004); none of the collection sites were greater than 70m above sea level.

The present contribution represents the first time that *Glossogobius* sp. 4 has been formally reported from the Saltwater Creek catchment. These new records of *Glossogobius* sp. 4 near Mossman are at least 70km north from the most northerly location of its previously recorded range (Hills Creek and Falls Creek; Wager, 1993).

The species has previously been overlooked in Saltwater Creek primarily because the 1995 (Russell et al., 1998) and 2004 surveys were the first to be conducted in the catchment. In contrast, despite several surveys and the species being easy to catch, *Glossogobius* sp. 4 has not been recorded in Wet Tropics rivers between Trinity Inlet and Saltwater Creek (Russell et al., 1993, 2000; Pusey & Kennard, 1994, 1996). To elucidate the relationship between the southern and northern populations and potential distribution patterns, a genetic study of the two populations would be of interest.

Glossogobius sp. 4 is currently listed as 'Lower Risk – Near Threatened' by the Australian Society for Fish Biology (2004), as 'Restricted' by Wager (1993), and as 'Rare' by Wager & Jackson (1993). While the species was originally listed due to its very restricted distribution, the new records extend its range and add approximately 10% in catchment area to its previously known area of distribution. The results presented here do not immediately call for a revision of this listing, but rather for a more detailed survey of coastal drainages to confirm the distribution, and thereby evaluate whether the listing is appropriate.

ACKNOWLEDGEMENTS

Thanks to Andrew Palmer for his help in the field, to Doug Hoese and Helen Larson for confirming our identifications, to Brad Pusey for distributional records in the Russell/Mulgrave basin, and to Caroline Bruce for assistance with map production. The fieldwork in 2004 was funded by the generous support of Earthwatch Institute, and by CSIRO's Water for a Healthy Country National Research Flagship. Comments by Brad Pusey, David Westcott, Tarmo Raadik, and Mark Kennard improved the paper. Collections in 2004 were conducted under Animal Research Permits to F. Kroon.

LITERATURE CITED

ALLEN, G.R. 1989. Freshwater fishes of Australia. (T.F.H. Publication: Neptune City, New Jersey).

ALLEN, G.R., MIDGLEY, S.H. & ALLEN, M. 2002. Field guide to the freshwater fishes of Australia. (CSIRO Publishing: Collingwood).

AUSTRALIAN SOCIETY FOR FISH BIOLOGY (2004). Conservation Status of Australian Fishes

TABLE 1. Queensland Museum records (QM) and 2004 survey captures (not retained) of *Glossogobius* sp. 4 from the Saltwater Creek catchment. All collections were made using (backpack) electrofishing. Main channel refers to the freshwater section of Saltwater Creek downstream from Pollock's crossing; n/a refers to fish that were collected, identified, and returned to the point of capture.

QM Reg. No.	No. individuals	Tributary	GPS		Collector	Collection date
			Latitude	Longitude		
QM I.30461	2	Little Falls Creek	16° 23' 34"S	145° 20'E	P. Hales	27/09/1995
QM I.30467	3	Pollock's Crossing	16° 25' 30"S	145° 21' 18"E	P. Hales	4/10/1995
QM I.30469	3	Bamboo Creek	16° 20'S	145° 23' 17"E	P. Hales	10/08/1995
QM I.30471	6	Whyanbeel Creek	16° 23' 34"S	145° 20' 49"E	P. Hales	27/09/1995
QM I.30473	4	Chinaman Creek	16° 21' 42"S	145° 21' 12"E	P. Hales	3/10/1995
QM I.30478	5	Boulder Creek	16° 22' 18"S	145° 19' 36"E	P. Hales	3/10/1995
n/a	16	Main channel 1	16° 25' 02"S	145° 21' 21"E	F. Kroon	8/03/2004
n/a	6	Main channel 1	16° 25' 02"S	145° 21' 21"E	A. Palmer	11/03/2004
QM I.35990	5	Main channel 1	16° 25' 02"S	145° 21' 21"E	F. Kroon	9/06/2004
n/a	19	Main channel 1	16° 25' 02"S	145° 21' 21"E	F. Kroon	9/06/2004
n/a	5	Main channel 1	16° 25' 02"S	145° 21' 21"E	A. Palmer	10/06/2004
n/a	1	Main channel 2	16° 24' 23"S	145° 21' 22"E	F. Kroon	9/12/2004
n/a	3	Main channel 3	16° 24' 25"S	145° 21' 22"E	F. Kroon	9/12/2004
n/a	4	Main channel 3	16° 24' 25"S	145° 21' 22"E	A. Palmer	13/12/2004

— 2004. Australian Society for Fish Biology Newsletter 34: 59–64.

HERBERT, B. & PEETERS, J. 1995. Freshwater fishes of Far North Queensland. QI95018. (Queensland Department of Primary Industries: Brisbane).

JOHNSON, J. 2000. Freshwater and upper estuarine fishes. Pp. 134–169. In Ryan, M. & Burwell, C. (eds) Wildlife of Tropical North Queensland. (Queensland Museum: Brisbane).

MERRICK, J.R. & SCHMIDA, G.E. 1984. Australian freshwater fishes: biology and management. (Griffin Press Ltd.: Netley, South Australia)

PUSEY, B.J., ARTHINGTON, A.H. & READ, M.G. 1995. Species richness and spatial variation in fish assemblage structure in two rivers of the Wet Tropics of northern Queensland, Australia. Environmental Biology of Fishes 42: 181–199.

PUSEY, B.J. & KENNARD, M.J. 1994. The freshwater fish fauna of the Wet Tropics region of northern Australia. Report to the Wet Tropics Management Authority, Cairns. (Griffith University: Nathan).

1996. Species richness and geographical variation in assemblage structure of the freshwater fish fauna of the Wet Tropics region of northern Queensland. Marine and Freshwater Research 47: 563–73.

PUSEY, B.J., KENNARD, M.J. & ARTHINGTON, A.H. 2004. Freshwater fishes of north-eastern Australia. (CSIRO Publishing: Collingwood).

RUSSELL, D.J. & HALES, P.W. 1993. Stream habitat and fisheries resources of the Johnstone river catchment. QI93056. (Queensland Department of Primary Industries: Brisbane).

RUSSELL, D.J., HALES, P.W. & HELMKE, S.A. 1996a. Stream habitat and fisheries resources in the Russell and Mulgrave rivers catchment. QI96008. (Queensland Department of Primary Industries: Brisbane).

1996b. Stream habitat and fisheries resources of the Moresby river. QI96061. (Queensland Department of Primary Industries: Brisbane).

RUSSELL, D.J. & HALES, P.W. 1997. Fish resources and stream habitat of the Liverpool, Maria and Hull catchments. QI97039. (Queensland Department of Primary Industries: Brisbane).

RUSSELL, D.J., MCDOUGALL, A.J. & KISTLE, S.E. 1998. Fish resources and stream habitat of the Daintree, Saltwater, Mossman and Mowbray catchments. QI198062. (Queensland Department of Primary Industries: Brisbane).

RUSSELL, D.J., MCDOUGALL, A.J., RYAN, T.J., KISTLE, S.E., ALAND, G., COGLE, A.L. & LANGFORD, P.A. 2000. Natural resources of the Barron river catchment 1. Stream habitat, fisheries resources and biological indicators. QI00032. (Queensland Department of Primary Industries: Brisbane).

WAGER, R. 1993. The distribution and conservation status of Queensland freshwater fishes. QI93001. (Queensland Department of Primary Industries: Brisbane).

WAGER, R.N.E. & JACKSON, P.J. 1993. The action plan for Australian Freshwater Fishes. Report to the Australian Nature Conservation Agency,

AN ACCOUNT OF THE PANDALOID SHRIMPS (CRUSTACEA: DECAPODA: CARIDEA) IN THE COLLECTIONS OF THE QUEENSLAND MUSEUM

XINZHENG LI AND PETER J. F. DAVIE

Li, X. & Davie, P. J.F. 2006 11 10: An account of the pandaloid shrimps (Crustacea: Decapoda: Caridea) in the collections of the Queensland Museum. *Memoirs of the Queensland Museum* **52**(1): 151–170. Brisbane. ISSN 0079-8835.

The pandaloid shrimp collection of the Queensland Museum was critically examined and re-identified. Of the 30 species represented, seven were found to be new distributional records for Australia, viz.: *Chlorocurtis jactans* (Nobili, 1904), *Plesionika albocristata* Chan & Chuang, 2002, *Plesionika crosnieri* Chan & Yu, 1991, *Plesionika echinicola* Chan & Crosnier, 1991, *Plesionika izumiae* Omori, 1971, *Plesionika narval* (Fabricius, 1787), *Plesionika sindoi* (Rathbun, 1906). A further 10 species are new records for Queensland waters. *Pandalus (Parapandalus) leptorhynchus gibber* Hale, 1924 is established as a new junior subjective synonym of *Chlorotocella gracilis* Balss, 1914. ❐ *Caridea, Pandaloidea, Pandalidae, Thalassocarididae, new records, new synonym, Queensland.*

Xinzheng Li, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China; Peter J. F. Davie, Queensland Museum, PO Box 3300, South Brisbane, Qld, Australia; *23 August 2006.*

The collection of the Queensland Museum, South Brisbane, includes a reasonably large collection of caridean shrimps, collected mainly from off Queensland and adjacent waters. The bulk of the samples were collected by surveys undertaken between 1979 to 1988 by the Queensland Fisheries Service (QFS) [now the Queensland Department of Primary Industries and Fisheries], and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) using the research vessels *Soela*, *Southern Intruder*, *Southern Surveyor*, *Valkyrie Voyager*, *Gwendoline May* and *Craigmin*. The present paper reports the results of taxonomic research on these specimens.

Measurements are of post orbital carapace length unless otherwise stated. Abbreviations: cl = carapace length; Cr. = Cruise; QFS = Queensland Fisheries Service; QM = Queensland Museum; SAM = South Australian Museum; Qld = Queensland; NSW = New South Wales; SA = South Australia; WA = Western Australia.

TAXONOMY

Family Pandalidae

Chlorocurtis jactans (Nobili, 1904) (Fig. 1A)

Virbius (?) *jactans* Nobili, 1904: 230; 1906: 37, pl. 2, fig. 2.
Chlorocurtis miser Kemp, 1925: 280.
Chlorocurtis jactans: Holthuis, 1955: 128, fig. 91; 1993: 265, fig. 262; Ledoyer, 1969: 67, pl. I, figs 1A–4A, pl. 14B; 1984: 33, fig. 15; Bruce, 1976: 60; De Grave, 2001: 47.

MATERIAL. QMW20718, ♀ (1.5mm), Green Island, NE Qld, 16°45.5'S, 145°58.2'E, Stn HIPA19, 3.5m, from seagrass bed of *Halodule uninervis* and *Cymodocea serrulata*, sand/shell, trawled, L. McKenzie, 30.05.1989.

REMARKS. The female specimen agrees closely with Kemp's (1925) description (as *Chlorocurtis miser*) except for slight rostral differences. The rostrum has a series of 7 dorsal teeth, with the posterior tooth not particularly more distant from the second than the second is from the third, and the second tooth has a suture at its base. *Chlorocurtis* is currently considered monotypic. This small species has been previously recorded from *Cymodocea* seagrass beds, and algal *Sargassum* beds (Bruce, 1976), and from the base of soft coral (De Grave, 2001). The association with *Halodule uninervis* has not been previously reported.

DISTRIBUTION. Red Sea, Kenya, Andaman Islands, Singapore, New Caledonia, Gilbert Islands, Papua New Guinea. Not previously recorded from Australia.

Chlorotocella gracilis Balss, 1914 (Fig. 1B)

Chlorotocella gracilis Balss, 1914: 33, figs 16–22; De Man, 1920: 110, 180, pl. 15, fig. 45, 45a; Kemp, 1925: 278; Hayashi & Miyake, 1968: 12, figs 1a–c, 4a; Ledoyer, 1984: 33, fig. 16; Chace, 1985: 11; Hayashi, 1986: 114, 115, 266, fig. 72; Bruce, 1988: 235; Bruce & Coombes, 1997: 331; Davie, 2002: 344; Li & Komai, 2003: 258–259.
Pandalus (Parapandalus) leptorhynchus gibber Hale, 1924: 68, pl. iv, figs 6, 7.

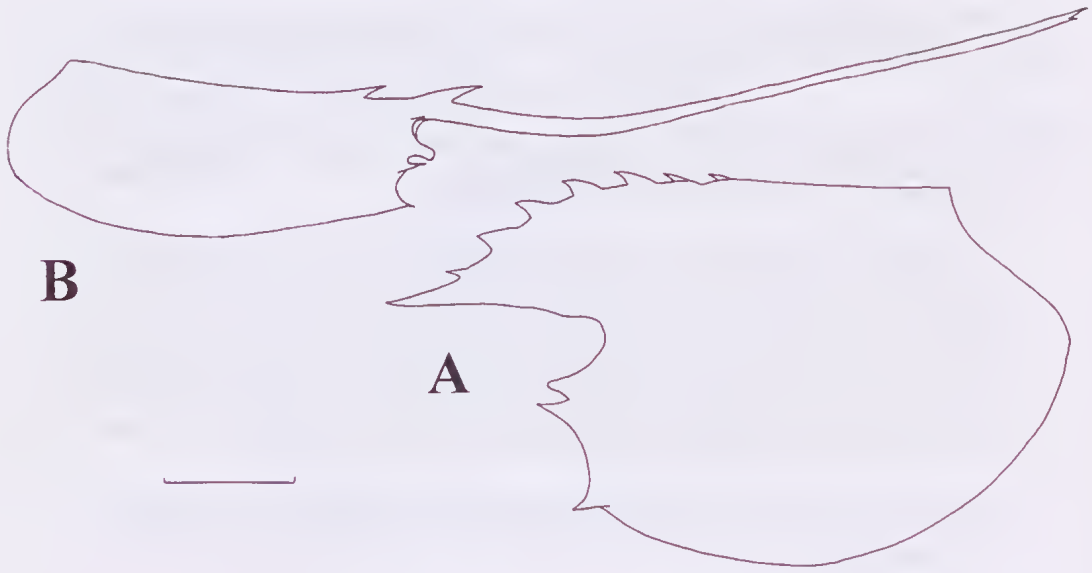


FIG. 1. Carapace, lateral view. A, *Chlorocurtis jactans* (Nobili, 1904), QMW20718; B, *Chlorotocella gracilis* Balss, 1914, QMW7236, female, scale = 1mm (A); 0.5mm (B).

Parapandalus leptorhynchus gibber: Hale, 1927: 44, fig. 35.

MATERIAL. QMW20387, ♂ (3.1mm), 2 ♀♀ (2.3, 2.9mm), ovig. ♀ (3.4mm), Gagg Is., Kimberley coast, WA, 16°11.2'S, 123°27.2'E, Stn 21, 20m, fringing reef, associated with gorganacean coral, J. Short, 26.11.1994; QMW7236, 2 ♂♂ (4.2, 4.5mm), 2 ♀♀ (5.3, 5.44mm), Redland Bay, Moreton Bay, Qld, 27°40.5'S, 153°19'E, CSIRO, 8.08.1972.

REMARKS. Besides *Chlorotocella gracilis*, two other Australian species are referable to *Chlorotocella*, *viz*. *Hippolyte spinicaudus* H. Milne Edwards, 1837 (= *Pandalus leptorhynchus* Stimpson, 1860, see Holthuis (1995: 144) and Davie (2002: 344)), and *Parapandalus leptorhynchus gibber* Hale, 1924 (Hale, 1924, 1927; Li & Komai, 2003). There have been few reports of either species since Hale (1927).

Pandalus leptorhynchus was transferred to *Chlorotocella* by Holthuis (1947), and subsequently established as a junior synonym of *C. spinicaudus* (H. Milne Edwards, 1837) by Holthuis (1995). It differs from *Chlorotocella gracilis* Balss, 1914, because its rostrum has 2–5 ventral teeth, whereas *C. gracilis* has only a single ventral subapical tooth.

However, the taxonomic status of *Pandalus (Parapandalus) leptorhynchus gibber* Hale, 1924, has remained uncertain. Hale's (1924, 1927) description and figures appear very similar to *Chlorotocella gracilis*. Thierry Laperousaz of the South Australian Museum kindly sent to us type and other specimens of *P.(P.) leptorhynchus gibber* identified by Hale. Unfortunately they are in poor condition. SAM C 206 is a paratype ovigerous female of '*Parapandalus leptorhynchus gibber* Hale 1924' collected from St Vincents Gulf, South Australia. It is a dry specimen, and the rostrum and most of the pereiopods are lost. It looks identical to *Chlorotocella gracilis* Balss, 1914.

All the rest of the loaned material is here re-identified as *Chlorotocella spinicaudus* (H. Milne Edwards, 1837). SAM C6273, consists of only dry abdomens; SAM C6274 has the name '*Pandalus leptorhynchus ?* Stimpson' on the label, and consists of four dry specimens, all distinctly smaller than the paratype female above — one of these bears two ventral rostral teeth at 0.5 and 0.75 of the rostral length and one subapical ventral tooth, and thus is here re-identified as *Chlorotocella spinicaudus* (H. Milne Edwards, 1837), however it is not possible to see the ventral rostral margin on the other three, so their identity cannot be definitely confirmed but all can be assumed to be *C. spinicaudus*. SAM C201, consists of 48 specimens, including 18 ovig. females, was collected from St Vincents Gulf, South Australia, on 12 April 1924. It was identified as '*Pandalus leptorhynchus* Stimpson' by Hale. All the available specimens have a very slender and short rostrum, usually just over-reaching the end

of the scaphocerite, about 0.9 times as long as carapace, always armed with one dorsal tooth on about the proximal 1/5 to 1/3, an epigastric tooth on the carapace, and usually three ventral teeth on the distal half (including the subapical tooth). The largest ovigerous female (c.l. 6.0mm) has the longest rostrum (1.1 times carapace length), over-reaching the end of the scaphocerite by distal 1/6, and is armed ventrally with five teeth on distal 0.6 rostral length. SAM C202, is an ovigerous female collected from same locality and date as SAM C201, and is clearly the same species. SAM C203, is an ovigerous female collected from Geographe Bay, WA on 12 April 1924, and again is same species as SAM C201. SAM C204 consists of 4 ovigerous females (5.3–5.9mm) collected from Nuyts Arch., South Australia, by dredge at 3–4 fathoms on 12 April 1924. They are very similar to the largest ovigerous female of SAM C201, and therefore we consider them to be also the same species.

Thus after examining all the available material from the South Australian Museum we can confirm that *Parapandalus leptorhynchus gibber* Hale, 1924, is a junior synonym of *Chlorotocella gracilis* Balss, 1914, and that only *C. gracilis* Balss, 1914 and *C. spinicaudis* (H. Milne Edwards, 1837) occur in Australia.

ECOLOGY. From low intertidal pools to about 91m depth; one record associated with a gorgonian, *Junceella fragilis*.

DISTRIBUTION. Andaman and Nicobar Islands, Singapore, Indonesia, Philippines, East and South China Seas, Japan, Australia. The present species was recorded previously in Australian waters by Bruce (1988) and Bruce & Coombes (1997) from the East Point Fish Reserve, Darwin Harbour, Northern Territory.

Chlorotocus novaezealandiae (Borradaile, 1916)

Thalassocaris novae-zealandiae Borradaile, 1916: 84, fig. 2
Chlorotocus novaezealandiae: Crosnier & Forest, 1973: 186; Chace, 1985: 11; Kensley et al., 1987: 312; Davie, 2002: 345.

MATERIAL. QMW18034, ovig. ♀ (11.4mm), off Tully, Qld, 17°58.7'S, 147°08.7'E, trawled, CSIRO, R.V. *Soela*, C0685A91, 325–328m, 9.12.1985; QMW26769, 2 ovig. ♀♀ (10.9, 12.2mm), CSIRO Cr. 0186, Stn 21, 12.01.1986; QMW26770, ♀ (11.5mm), 2 ovig. ♀♀ (11.3, 12.9mm), CSIRO Cr. 0186, Stn 63, 19.01.1986; QMW26771, ♂ (12.0mm), 17°59'S 147°02'E–17°57'S, 147°00'E, *Soela*, Cr. 6, Stn 44, 250–252m, P. Davie, 29.11.1985.

REMARKS. There are currently two recognised species of *Chlorotocus viz*, *C. crassicornis* (Costa, 1871) and *C. novaezealandiae* (Borradaile, 1916). They can be distinguished by the length of the rostrum and body size (Crosnier & Forest, 1973; Kensley et al., 1987). In *C. novaezealandiae* the rostrum just reaches or only slightly over-reaches the distal article of the antennular peduncle, and the carapace length of ovigerous females is from 10.8–14.0mm. In *C. crassicornis* the rostrum reaches well beyond the distal segment of the antennular peduncle, and the carapace length of ovigerous females is from 16.5–20.0mm (Kensley et al., 1987). However, Li & Komai (2003) have recently cast some doubt on the value of these characters. An examination of a large number of *C. crassicornis* from northern South China Sea showed considerable variation in the relative length of the rostrum and the size of female maturity. The rostrum of those specimens ranged from distinctly not-reaching to distinctly over-reaching the end of the last segment of the antennular peduncle, and the carapace length of the ovigerous females ranged from 8.3 to 21.1mm. The largest female examined by Crosnier & Forest (1973) was only 12.2mm in carapace length. It is clear that a larger study of variation across both species is necessary to be sure of their taxonomic distinction. We have identified the present specimens as *C. novaezealandiae*, based on the previous understanding of the species separation i.e. having a shorter rostrum and a relatively small body size.

There is a third, unnamed species of *Chlorotocus* from Japan, previously reported under the name *C. incertus* by Balss (1914: 33) [not *C. incertus* Bate, 1888, which is believed to be a junior synonym of *C. crassicornis*] (see Crosnier & Forest, 1973: 185; and Chace, 1985: 11). This species is apparently characterised by having its two posterior abdominal somites uniquely different from the named species discussed above.

DISTRIBUTION. Previously recorded from New Zealand in 128m depth (Borradaile, 1916) and off New South Wales at 40m (Kensley et al., 1987). The present record extends the range of the species northward to Queensland (17°59'S) and extends the known depth range to 328 meters.

Heterocarpus calmani Crosnier, 1988

Heterocarpus Wood-Masoni: Balss, 1925: 286 (in part); Calman, 1939: 204 (not *H. woodmasoni* Alcock, 1901)

Heterocarpus woodmasoni: Kensley, 1969: 170, fig. 12; Holthuis, 1980: 137 (in part).
Heterocarpus calmani Crosnier, 1988: 59, fig. 1a–h; Davie, 2002: 345.

MATERIAL. QMW11308, 5 ♂♂ (21.4–23.8mm), ♀ (26.4mm), eastern Australia, 23°21'S, 153°23'E, 410m, *Southern Intruder* Survey, shot 41, P. Davie, 30.11.1983; QMW11283, 5 ovig. ♀♀ (21.5–25.6mm), eastern Australia, 23°22'S, 152°45'E, 350–310m, *Southern Intruder* Survey, shot 42, P. Davie, 30.11.1983; QMW11286, ♂ (25.4mm), eastern Australia, 23°52'S, 153°02'E, 650m, *Southern Intruder* Survey, shot 2, P. Davie, 29.11.1983; QMW11293, ♂ (17.3mm), ♀ (19.0mm), ovig. ♀ (19.0mm), eastern Australia, 23°52'S, 153°02'E, 650m, *Southern Intruder* Survey, shot 2, P. Davie, 29.11.1983; QMW11315, 3 ♂♂ (19.1, 20.8, 22.9mm), ♀ (23.5mm), 4 ovig. ♀♀ (22.4–26.5mm), eastern Australia, 23°54'S, 153°01'E, 465m, *Southern Intruder* Survey, shot 1, P. Davie, 29.11.1983; QMW11417, ♂ (20.0mm), eastern Australia, 23°46'S, 153°06'E, 550m, *Southern Intruder* Survey, shot 3, M. Dredge, 9.08.1983; QMW11460, 2 ♂♂ (21.2, 21.5mm), 4 ♀♀ (17.2–23.0mm), 2 ovig. ♀♀ (22.4, 23.0, 24.4mm), eastern Australia, 23°59'S, 152°59'E, 380m, *Southern Intruder* Survey, M. Dredge (Q.F.S), 8.08.1983; QMW10062, 2 ♂♂ (21.5, 22.7, another's carapace damaged), 3 ♀♀ (15.7, 18.0, 21.4mm), 23°00.3'S, 152°12.5'E, 387m, *Craigmin* Survey, Stn 24, QFS, 3.10.1980; QMW10063, ♂ (21mm), 23°28'S, 153°19'E, 562m, *Craigmin* Survey, Stn 6, QFS, 20.09.1980; QMW10064, ♂ (20.6mm), 23°30'S, 153°04'E, 540m, *Craigmin* Survey, Stn 7, QFS, 20.09.1980; QMW26774, ♀ (18.0mm), E. of Tully, 17°59'S 147°09'E–17°55'S, 147°06'E, *Soela*, Cr. 6, Stn 47, 400m, P. Davie, 29.11.1985; QMW26758, ♂ (21.9mm), Deep Water Survey, *Southern Intruder*, M. Dredge (QFS).

REMARKS. The present material has been previously reported by Crosnier (1999). The species was long confused with *Heterocarpus woodmasoni* Alcock, 1901, until described as a separate species by Crosnier (1988). It differs from *H. woodmasoni* and *H. intermedius* Crosnier, 1999, by having an obvious postrostral crest and only two pairs of dorsolateral spines on the telson (excluding the subapical spines).

DISTRIBUTION. So far only known from NE Queensland and east Africa, Madagascar.

Heterocarpus dorsalis Bate, 1888

Heterocarpus dorsalis Bate, 1888: 630, pl. 111; De Man, 1920: 109, 171, pl. 15, fig. 43–43g; Balss, 1925: 285; Barnard, 1950: 684, fig. 127a; Zarenkov, 1971: 191, figs 1(11–12), 4(1–15); Chace, 1985: 22, fig. 13d; Hayashi, 1986: 116, 117, 267, photo 73; Crosnier, 1988: 62, figs 2, 3; Hanamura & Takeda, 1987: 107; Takeda & Hanamura, 1994: 20; Hanamura & Evans, 1996: 5; Davie, 2002: 345; Fransen, 2006: 52-55, figs. 1, 4-6, 7, 10, 13.
Heterocarpus alphonsi Bate, 1888: 632, pl. 112, fig. 1; De Man, 1920: 108.
Heterocarpus dorsalis ssp. *Alphonsi*: Monod, 1973: 123, figs 28–31.
Heterocarpus affinis: Borradaile, 1915: 208; Borradaile, 1917: 399; De Man, 1920: 108 (not Faxon, 1893).

MATERIAL. QMW18036, 2 ♂♂ (21.4, 23.2mm), ovig. ♀ (26.3mm), off Cairns, Qld, 17°01.8'S, 151°20.1'E, 802–792m, continental slope, trawled, CSIRO, R.V. *Soela*, C0685A79, 6.12.1985; QMW18035, ♀ (18.5mm), ovig. ♀ (19.7mm), off Cairns, Qld, 16°55.9'S, 151°34.6'E, 880m, continental slope, trawled, CSIRO, R.V. *Soela*, C0685A78, 6.12.1985; QMW18058, ♂ (16.1mm), 2 ovig. ♀♀ (21.9, 25.1mm), off Innisfall, Qld, 17°30.1'S, 149°00.4'E, 900–908m, continental slope, trawled, CSIRO, R.V. *Soela*, C0685A59, 2.12.1985.

DISTRIBUTION. A common Indo-West Pacific species, occurring from eastern Africa to Indonesia, Philippines, Japan, New Caledonia, and western Samoa. Previously recorded in Australia from NW continental slope (Hanamura & Takeda, 1987) and Western Australia (Hanamura & Evans, 1996); this is the first record from eastern Australia. Bathymetric range: 185 to 1400m.

Heterocarpus hayashii Crosnier, 1988

Heterocarpus sibogae: Chace, 1985: 11 (in part), fig. 20; Hayashi, 1986: 118, 119, 268, fig. 76; Chan & Yu, 1987: 57 (part), pl. 2, fig. c; Hanamura & Takeda, 1987: 107, fig. 1b.
Heterocarpus hayashii Crosnier, 1988: 67, figs 4b, 5b, pls 1d, 3e–e; Hanamura & Evans, 1996: 7, fig. 2; Davie, 2002: 346; Li & Komai, 2003: 259–260.

MATERIAL. QMW8234, 5 ♂♂ (24.4–32.7mm), 4 ♀♀ (22.8–24.0mm), 11 ovig. ♀♀ (25.2–32.0mm), 11°35'S, 144°04'E, 2–5 miles ENE Raine Island, AIMS, AMS, AMUS, 12.02.1979; QMW14312, 2 ♀♀ (28.6, 30.5mm), 27°13.00'S, 153°52.53'E, 590m, M.V. *Iron Summer*, trawled, shot 1, R. Morton (QFS), 9.05.1983; QMW14331, ovig. ♀ (34.2mm), 27°12'83"S, 153°52'87"E, SE Qld, M.V. *Iron Summer*, trawled, shot 3, R. Morton (QFS), 10.05.1983; QMW14335, ♀ (31.7mm), 27°19'91"S, 153°53'47"E, SE Qld, 660m, M.V. *Iron Summer*, trawled, QFS, 10.05.1983; QMW14343, ♀ (31.8mm), 27°35.04'S, 153°57.32'E, 545m, M.V. *Iron Summer*, trawled, shot 3, R. Morton, 31.03.1983; QMW14348, 2 ♂♂ (28.4, 29.4mm), ovig. ♀ (32.7mm), 26°30'S, 153°45'E, 390m, M.V. *Iron Summer*, trawled, shot 2, G. Smith (QFS), 13.12.1982; QMW14357, ♂ (37.1mm), 2 ovig. ♀♀ (32.8, 33.7mm), 26°31'S, 153°48'E, SE Qld, 570m, M.V. *Iron Summer*, trawled, shot 1, G. Smith (QFS), 13.12.1982; QMW11321, 3 ♂♂ (27.1, 27.3, 31.0mm), 13 ovig. ♀♀ (29.6–38.0mm), 23°54'S, 152°01'E, 465m, *Southern Intruder*, trawled, shot 1, P. Davie, 29.11.1983; QMW11316, ♂ (26.9mm), 2 ovig. ♀♀ (37.4, 36.7mm), 23°21'S, 153°23'E, 410m, *Southern Intruder*, trawled, shot 41, P. Davie, 30.11.1983; QMW11314, ♀ (32.4mm), ovig. ♀ (27.8mm), 23°52'S, 153°02'E, 650m, *Southern Intruder*, trawled, shot 2, P. Davie, 29.11.1983;

QMW11321, 4 ♂♂ (28.1–38.3mm), ♀ (30.8mm), 2 ovig. ♀♀ (35.9, 36.0mm), 23°22'S, 152°45'E, 350–310m, *Southern Intruder*, trawled, shot 42, P. Davie, 30.11.1983; QMW11388, 2 ♀♀ (29.4, 34.9mm), 4 ovig. ♀♀ (28.8–34.7mm), 23°51'S, 153°00'E, 460m, *Southern Intruder*, trawled, shot 2, M. Dredge (QFS), 9.08.1983; QMW11424, 2 ♂♂ (31.4, 33.9mm), ♀ (33.8mm), 2 ovig. ♀♀ (35.0, 35.2mm), 23°46'S, 153°06'E, 550m, *Southern Intruder*, trawled, shot 3, M. Dredge (QFS), 9.08.1983; QMW14307, 2 ovig. ♀♀ (24.0, 28.2mm), 1 juvenile (12.3mm, unarmed dorsal margin 7.5mm), 17°38'S–149°23'E to 17°34'S–149°23'E, 600m, R.V. *Soela*, Cr. 6, Stn 60, trawled, P. Davie, 3.12.1985; QMW15931, 2 ♂♂ (26.6, 27.3mm), 2 ♀♀ (25.5, 32.6mm), 12 ovig. ♀♀ (27.5, 31.6mm), off Lihou Reef, Coral Sea, NE Qld, 600–700m, trapped, M.V. *Ocean Rover*, R. McAlister, Jun. 1989; QMW16206, 2 ♀♀ (29.3, 33.0mm), 15°58'S, 149°56'E, North Cay area, Willis Islets, FN Qld, 590m, M.V. *Valkyrie Voyager*, trawled, G. Williams, 30.06.1989; QMW16220, 1 ovig. ♀♀ (27.3mm), 16°55'S, 150°00'E, near Chilcott Is., Qld Plateau, NE Qld, 406m, M.V. *Valkyrie Voyager*, trawled, G. Williams, 3.07.1989; QMW10051, ovig. ♀ (31.9mm), 26°31'S, 153°48'E, *Craigmin* Survey, Stn 1, 480m, QFS, 13.09.1980; QMW10052, 12 ♂♂ (31.0–35.3mm), ♀ (35.1mm), 8 ovig. ♀♀ (30.3–35.5mm), 23°30'S, 153°04'E, *Craigmin* Survey, Stn 7, 540m, QFS, 20.09.1980; QMW10053, 21 ♂♂ (31.2–37.5mm), 9 ovig. ♀♀ (32.5–34.8mm), 23°28'S, 153°19'E, *Craigmin* Survey, Stn 6, 562m, QFS, 20.09.1980; QMW10054, 3 ♀♀ (30.0, 33.8mm, another damaged), 23°28'S, 153°19'E, *Craigmin* Survey, Stn 6, 562m, QFS, 20.09.1980; QMW10055, ♂ (34.5mm), 2 ♀♀ (32.3, 33.3mm), 3 ovig. ♀♀ (33.8, 33.8, 34.7mm), 23°28'S, 153°19'E, *Craigmin* Survey, Stn 6, 562m, QFS, 20.09.1980; QMW10056, ♀ (34.8mm), ovig. ♀ (35.0mm), 23°15.3'S, 154°14'E, *Craigmin* Survey, Stn 26, 549m, QFS, 4.10.1980; QMW10057, ovig. ♀ (35.6mm), 22°36.7'S, 154°14'E, *Craigmin* Survey, Stn 25, 522m, QFS, 4.10.1980; QMW10058, 2 ♀♀ (35.0mm, another damaged), 22°10'S, 154°10'E, *Craigmin* Survey, Stn 9, 570m, QFS, 21.09.1980; QMW10059, 2 specimens (damaged, 29.5, 34.1mm), 23°30'S, 153°04'E, *Craigmin* Survey, Stn 7, 540m, QFS, 20.09.1980; QMW10060, ♂ (35.5mm), 1 specimen (damaged, 30.6mm), 22°36.7'S, 154°14'E, *Craigmin* Survey, Stn 25, 522m, QFS, 4.10.1980; QMW10061, ♂ (31.8mm), 5 ♀♀ (25.0–33.8mm), ovig. ♀ (32.6mm), 23°28'S, 153°19'E, *Craigmin* Survey, Stn 6, 562m, QFS, 20.09.1980; QMW11201, 4 ♂♂ (27.4–33.2mm), 4 ♀♀ (26.6–28.0mm), 3 ovig. ♀♀ (25.0, 27.2, 32.6mm), 5 juvenile, 9°50'S 144°11'E–9°51'S 144°09'E, east of Murray Isles, 460–464m, QFS, R.V. Gwendolyn May, 27.05.1993; QMW11202, 7 ♂♂ (25.8–32.6mm), 4 ♀♀ (24.3–29.5mm), 3 ovig. ♀♀ (30.6, 30.8, 32.8mm), 15 juvenile, 9°51'S 144°26'E–9°53'S 144°23'E, east of Murray Isles, 480m, QFS, Gwendolyn May, 28.05.1993; QMW26768, ovig. ♀ (32.4mm), 27°16'S, 153°53'E, 540m, M.V. *Iron Summer*, trawled, shot 5, 13.08.1982; QMW26762, 2 ♀♀ (18.3, 19.7mm), 27°36'S, 153°36'E, SE Qld, 540m, M.V. *Iron Summer*, trawled, shot 6, R. Dutton, 29.07.1982; QMW26750, ovig. ♀ (33.4mm), 27°13' to 27°22'S, 153°00'E, 500–540m, M.V. *Iron Summer*, trawled, shot 1–7, M. Holmes, 2–3.10.1982; QMW26738, 9 ♂♂ (29.7–35.8mm), 4 ovig. ♀♀ (29.1–39.3mm), 23°28'S, 153°00'E, 110m, *Southern Intruder*, trawled, shot 57, QFS, NE of Bunker Group, 3.08.1984.

REMARKS. *Heterocarpus hayashii* is very similar to *H. sibogae* De Man, 1917. On fresh specimens, the red patches on the carapace and abdomen may help to distinguish *H. hayashii*, however the patches fade quickly after death. Crosnier (1988) remarked that the two species can be separated by the relative lengths of the posteromedial spines on the third and fourth abdominal somites. This can be a simple and easy method to identify alcohol preserved specimens, but these spines are often broken and damaged, and sometimes they can be sufficiently variable to be unreliable (Hanamura & Evans, 1996). Hanamura & Evans (1996) alternatively suggested that the two species can be separated by differences in length of the unarmed portion of the dorsal carapace margin. Our specimens had more than half the dorsal carapace margin unarmed, and this was consistent with longer posteromedial spines on the third abdominal somite than on the fourth (as suggested by Crosnier, 1988).

DISTRIBUTION. Japan, East and South China Seas, Philippines, New Caledonia, Samoa, eastern and western Australia; at depths of 200–700m.

Heterocarpus intermedius Crosnier, 1999

Heterocarpus intermedius Crosnier, 1999: 346, fig. 1; Davie, 2002: 346.

MATERIAL. QMW11317, ♂ (24.2mm), 4 ovig. ♀♀ (30.3–34.6mm), eastern Australia, 23°52'S, 153°02'E, 650m, *Southern Intruder* Survey, shot 2, P. Davie, 29.11.1983; QMW11309, ♂ (33.5mm), 4 ovig. ♀♀ (31.3–36.5mm), eastern Australia, 23°45'S, 153°07'E, 550m, *Southern Intruder* Survey, shot 3, P. Davie, 29.11.1983; QMW16211, ovig. ♀ (30.7mm), North Cay, Willis Islets, NE Qld, 15°58'S, 149°56'E, 590m, *Valkyrie Voyager*, G. Williams, 30.06.1989; QMW11419, ♂ (32.3mm), eastern Australia, 23°46'S, 153°06'E, 550m, *Southern Intruder* Survey, trawl, M. Dredge (QFS), 9.08.1983.

REMARKS. The present specimens have been previously reported by Crosnier (1999). The species was confused with *Heterocarpus woodmasoni* Alcock, 1901, and *H. calmani* Crosnier, 1988, until described as a separate

species by Crosnier (1999). It is closely allied to *H. calmani*, but lacks the postrostral crest characteristic of that species. Also on fresh specimens of *H. calmani* the prominent middle tooth on the third abdominal somite is coloured blackish with white longitudinal stripes, and a reddish black base, whereas in *H. intermedius* this tooth lacks any special colouring. *H. intermedius*, as its specific name indicates, is morphologically intermediate between *H. woodmasoni* and *H. calmani*: the telson is similar to that of *H. calmani*, while the rostrum and the colouration of the middle tooth on the third abdominal somite are similar to *H. woodmasoni*. The two species overlap in distribution in Queensland, and may even caught in the same trawl shot [e.g., QMW11317 (*H. intermedius*) and QMW11286, QMW11293 (*H. calmani*), QMW11309 (*H. intermedius*) and QMW11417 (*H. calmani*)]. It is thus apparent that while the morphological differences may be quite small, the species must be reproductively isolated.

DISTRIBUTION. East coast of Australia, New Caledonia, the Loyalty and Chesterfield Islands, and the Combe and Tusearora Banks.

Heterocarpus laevigatus Bate, 1888

Heterocarpus laevigatus Bate, 1888: 636, pl. 112, fig. 3; Alcock, 1901: 105; De Man, 1920: 109, 159, pl. 13, 37, 37b; Barnard, 1950: 684, fig. 127b; Figueira, 1957: 41, figs 5, 6, pl. 4, fig. 1; Crosnier & Forest, 1973: 195, fig. 61c; Chace, 1985: 33, fig. 13i; Hayashi, 1986: 118, 119, 268, photo 75; Crosnier, 1988: 74; Poupin, 1996: 8, pl. 3b; Davie, 2002: 346.

MATERIAL. QMW15930, ♂ (35.0mm), 3 ♀♀ (30.8, 36.4, 39.1mm), 9 ovig. ♀♀ (36.6–44.1mm), off Lihou Reef, Coral Sea, NE Qld, 17°S, 152°E, 600–700m, R. McAlister, M.V. *Ocean Rover*, June 1989.

DISTRIBUTION. Eastern Atlantic, South Africa to Indonesia, Western Australia and French Polynesia. The present material is the first record for eastern Australia.

Heterocarpus sibogae De Man, 1917

Heterocarpus sibogae De Man, 1917: 283; 1920: 109, 169, pl. 14, 42–42i; Monod, 1973: 122, figs 26, 27; Chace, 1985: 36 (in part, figs 13m, 18, 19); Chan & Yu, 1987: 57 (in part, pl. 2, fig. d); Crosnier, 1988: 79, fig. 5c, pl. 1, fig. c, pl. 3, figs a, b; Takeda & Hanamura, 1994: 21; Hanamura & Evans, 1996: 8, fig. 3; Davie, 2002: 347.
Heterocarpus sp.: Hayashi, 1986: 121, 269, fig. 77.

MATERIAL. QMW11961, 3 ♂♂ (31.2, 33.0, 33.8mm), ovig. ♀ (26.1mm), NW shelf, WA, KFV, Fisheries, Feb. 1986; QMW18050, ovig. ♀ (29.9mm), 17°38.1'S, 149°23.4'E, off Innisfall, Qld, trawled, Stn 60, continental slope, CSIRO, R.V. *Soela*, C0685A60, 604–600m, 3.12.1985; QMW18022, ♂ (30.3mm), 2 ovig. ♀♀ (28.3, 34.3mm), 17°01.8'S, 151°20.1'E, off Cairns, Qld, trawled, continental slope, CSIRO, R.V. *Soela*, C0685A79, 802–792m, 6.12.1985; QMW20791, 5 ♂♂ (30.5–36.8mm), ovig. ♀ (325mm), 18°06.0'S, 118°10.9'E, 390–250m, North West Shelf Area, WA, *Southern Surveyor*, trawled, Stn 124, continental slope, SS0895, S. Cook, 8.09.1995; QMW11312, 1 ♂♂ (29.2, 34.5mm), ovig. ♀ (36.4mm), 23°45'S, 153°07'E, 550m, *Southern Intruder*, trawled, shot 3, P. Davie, 29.09.1983.

DISTRIBUTION. Indo-Pacific: Andaman Sea, Indonesia, southern Philippines, Japan, New Caledonia, New Hebrides, Fiji, western Samoa, and western, southern and eastern Australia. Bathymetric range: 247–850m (mainly 320–520m).

REMARKS. See 'Remarks' for *Heterocarpus hayashii*. As the two species were confused prior to Crosnier (1988), the precise distribution of *H. sibogae* across the Indo-West Pacific region needs to be carefully reviewed.

Heterocarpus woodmasoni Alcock, 1901

Heterocarpus Wood-masoni Alcock, 1901: 108; De Man, 1920: 156, pl. 13, fig. 36.
Heterocarpus wood-masoni: Alcock & McArdle, 1901: pl. 51, fig. 2.
Heterocarpus woodmasoni: Chace, 1985: 42, fig. 13q; Kensley et. al., 1987: 313; Crosnier, 1988: 61, fig. 1i–l; 1999: 348; Davie, 2002: 347.

MATERIAL. QMW11962, 3 ♂♂ (32.2, 32.8, 32.8mm), NW Shelf, WA, KFV Fisheries, Feb. 1986; QMW8235, 20 ♂♂ (23.3–28.5mm), 17 ovig. ♀♀ (21.2–30.6mm), 11°35'S, 144°04'E, Coral Sea, 2–5 miles ENE of Raine Island, Qld, beam trawl, 12.02.1979; QMW10077, ♂ (22.2mm), 23°28'S, 153°19'E, 562m, *Craigmin* Survey, Stn 6, QFS, 20.09.1980; QMW26749, ovig. ♀ (23.5mm, damaged), 23°30'S, 153°04'E, 540m, *Craigmin* Survey, Stn 7, trawled, QFS, 20.09.1980; QMW11208, ♀ (26.6mm), 32 ovig. ♀♀ (24.3–30.8mm), 9°50'S 144°11'E–9°51'S 144°09'E, 460–464m, east of Murray Isles, QFS, *Gwendolyn May*, 27.05.1983; QMW11209, 3 ♂♂ (25.0, 25.8, 27.7), ♀ (30.0mm), 2 ovig. ♀♀ (27.2, 28.5mm), 9°50'S 144°11'E–9°51'S 144°09'E, 460–464m, east of Murray Isles, QFS, *Gwendolyn May*, 27.05.1983; QMW11207, ♂ (30.8mm), 44 ovig. ♀♀ (21.8–31.0mm), 9°51'S 144°26'E–9°53'S 144°23'E, 490m, east of Murray Isles, QFS, *Gwendolyn May*, 28.05.1983; QMW11211, 60 ♂♂ (22.5–32.4mm), ovig. ♀ (34.1mm), 9°51'S 144°26'E–9°53'S 144°23'E, 480m, east of Murray Isles, QFS, *Gwendolyn May*, 28.05.1983.

FIG. 2. *Plesionika albocristata* Chan & Chuang, 2002, anterior carapace, lateral view, QMW26746, scale = 5mm.

REMARKS. *Heterocarpus woodmasoui* is closely allied to *H. calmani* and *H. intermedius*, and prior to the description of the latter two species, records of all three were confounded under *H. woodmasoui*. Therefore the precise distribution of *H. woodmasoui* needs to be carefully reviewed. *H. woodmasoui* (W10077) has been caught in the same trawl shots as *H. caluani* (W10063).

DISTRIBUTION. South Africa to Indonesia, South China Sea, Philippines, NE and NW Australia.

Plesionika albocristata Chan & Chuang, 2002 (Fig. 2)

Plesionika albocristata Chan & Chuang, 2002: 611, figs 1, 2.

MATERIAL. QMW26746, ovig. ♀ (22.8mm), E. of Brisbane, 27°45.6'S, 153°58'E, 540m, *Iron Summer* Survey, trawled, shot 7, P. Dutton, 29.07.1982.

REMARKS. The species differs from all other members of *Plesionika* by its peculiar rostral crest, which has 2 very large broad fixed teeth in front of the orbit and 7–9 very small moveable teeth behind the postorbital margin. It further differs from the two most closely allied species, *P. rostricreseutis* (Bate, 1888) and *P. lophotes* Chace, 1985, by having a telson with 5 pairs of dorsolateral spines (including the pair adjacent to the lateral pair of posterior spines), and by having subequal second pereiopods. Our specimen closely agrees with the original description of Chan & Chuang (2002) except that the ventral rostral teeth look more widely separated than on the illustration of Chan & Chuang (2002), and the stylocerite is somewhat shorter, just over-reaching the end of the proximal article of antennular peduncle.

DISTRIBUTION. Previously known only from the type locality east of Taiwan. The present specimen is a new record for Australian waters and marks a major southerly range extension in the West Pacific. Bathymetric range: 350 to 423m (Chan & Chuang, 2002); 540m (present record).

Plesionika alcocki (Anderson, 1896)

Pandalus alcocki Anderson, 1896: 92.
Pandalus (Plesionika) alcocki : Alcock & McArdle, 1901: pl. 52, fig. 2.
Plesionika alcocki: De Man, 1920: 105; Balss, 1925: 278, fig. 48; Monod, 1973: 122, fig. 25; Chace, 1985: 55; Hayashi, 1986: 127, 270, fig. 81; Kensley, Tranter & Griffin, 1987: 313; Davie, 2002: 347; Fransen, 2006: 62-65, fig. 17.

MATERIAL. QMW18063, 4 ♂♂ (20.3–24.6mm), 5 ♀♀ (23.1–26.5mm), 11 ovig. ♀♀ (23.0–25.0mm), east of Brisbane, SE Qld, continental slope, 700–900 (22.9–24.1mm), 13 ovig. ♀♀ (21.6–27.5mm), east of Brisbane, SE Qld, 700–900m, *Valkyrie Voyager*, trawled, Wood Fisheries Pty Ltd., May 1988; QMW18040, ♂ (24.4mm), ovig. ♀ (28.5mm), 17°01.8'S, 151°20.1'E, off Cairns, Qld, 802–792m, R.V. *Soela*, trawled, C0685A79, CSIRO, 6.12.1985; QMW26766, 4 ♂♂ (15.9–23.5mm), 3 ovig. ♀♀ (24.1, 24.5, 26.4mm) 17°01.8'S 151°20.1'E, *Soela*, Cr. 6, Stn 79, 792-802m, 6.12.1985.

DISTRIBUTION. Indian Ocean, western Pacific; 500–1412m; previously recorded from Australia

between Point Danger, SE Qld, and Port Jackson, NSW from between 724–895m.

Plesionika bifurea Alcock & Anderson, 1894

Pandalus bifurca Alcock & Andersen, 1894: 155.
Pandalus (Plesionika) bifurca: Alcock & McArdle, 1901, pl. 51, fig. 6.
Plesionika bifurca: De Man, 1920: 105, 136, pl. 12, fig. 31, 31b; Chace, 1985: 56, fig. 24; Kensley, Tranter & Griffin, 1987: 314; Davie, 2002: 348; Li & Komai, 2003: 260; Fransen, 2006: 65-68, fig. 18.

MATERIAL. QMW26776, ovig. ♀ (10.8mm), 17°38'S 149°23'E to 17°34'S 149°23'E, 600m, *Soela*, Cr. 6, Stn 60, P. Davie, 3.12.1985.

DISTRIBUTION. Eastern Africa, Arabian Sea, Bay of Bengal, Andaman Sea, Indonesia, Philippines, South and East China Seas, Japan and Eastern and northwestern Australia. Bathymetrie range: 220–1412m.

Plesionika crosnieri Chan & Yu, 1991

Plesionika longirostris: Barnard, 1950: 681, fig.126n; Crosnier, 1976: 234, fig. 4a (in part); Suzuki, 1976: 46, figs 3, 4 (not *P. longirostris* Borradaile, 1900).
Plesionika edwardsii: Chace, 1985: 62, fig. 26a–3 (in part) (not Brandt, 1851).
Plesionika crosnieri Chan & Yu, 1991: 546, figs 1, 3a.

MATERIAL. QMW28050, ♂ (20.8mm), ♀ (16.5mm), E. of Bunker Group, 23°34'S, 153°16'E, 650m, *Southern Intruder*, trawled, Bottle 37c, shot 5, M. Dredge (QFS), 9.08.1983; QMW16211, ♂ (23.5mm), ♀ (26.8mm), 16°55'S, 150°00'E, near Chilcott Island, Qld Plateau, NE Qld, 406m, *Valkyrie Voyager*, trawled, B. Williams, 3.07.1989; QMW10067, ovig. ♀ (18.6mm), 26°20'S, 153°53'E, *Craigmin* Survey, Stn 2, 300m, QFS, 13.09.1980; QMW26767, 7 ovig. ♀♀ (dry), E. of Tweed Heads, NSW, 28°11'40"S, 153°54'E, *Iron Summer* Survey, Shot 1, 230–238m, P. Dutton, 27.07.1982.

REMARKS. *Plesionika crosnieri* is very close to *P. edwardsii* (Brandt, 1851). Chan & Yu (1991) indicated that fresh material of the two species is easy to distinguish because each has distinctive colouration. *P. crosnieri* has only one large fixed rostral tooth posterior to the orbital margin, and the distance between this tooth and the second tooth is more than that between the second and third tooth. *P. edwardsii*, has 2–4 dorsal rostral teeth located behind the orbital margin, with the most posterior being minute, variably movable, and close to the preceding tooth. Our specimens agree with Chan & Yu's (1991) description, in having only one large fixed dorsal rostral tooth posterior to the orbital margin, the stylocerite with its outer margin narrow and only very slightly curved upwards, and the basicerite spine not reaching the proximal end of the scaphocerite margin.

DISTRIBUTION. The present material is a new record for Australia, and extends the maximum known depth from 350m (Chan & Yu, 1991) to 650m. Known with certainty from eastern coast of South Africa, La Reunion, Crozet Islands, Indonesia, Philippines, Taiwan, Japan, New Caledonia, Australia. Bathymetrie range: 80–650m.

Plesionika echinicola Chan & Crosnier, 1991

Plesionika echinicola Chan & Crosnier, 1991: 416, figs 1a, 2a, 3a–b, 19, 20.

MATERIAL. QMW18037, ovig. ♀ (18.5mm), 17°58.7'S, 147°08.7'E, off Tully, Qld, 325–328m, continental slope, R.V. *Soela*, C0685A91, trawled, CSIRO, 9.12.1985.

REMARKS. Although the rostrum and most of the ambulatory pereiopods of the specimen are broken or missing, it agrees with the original description in having five dorsal post-rostral teeth, the posteroventral angle of the fourth abdominal somite having a denticle, the third maxilliped without an epipod, the carpus of the first pereiopod very short (0.62 times as long as the carapace), the second pereiopods subequal, with 22 carpal articles, and the telson 1.3 times as long as the sixth abdominal somite. The 12 dorsal teeth corresponding to the posterior 10 ventral rostral teeth of our specimen, is slightly more than the 8-10.5 dorsal teeth of the type series.

DISTRIBUTION. Previously recorded only from the type locality New Caledonia and Chesterfield Islands; 230–580m.

Plesionika edwardsii (Brandt, 1851)

Pandalus (Pontophilus) Edwardsii Brandt, 1851: 122.
Pandalus (Parapandalus) longirostris Borradaile, 1900: 413, pl. 37, figs 10, 10a–h.
Plesionika longirostris: De Man, 1920: 106; Barnard, 1950: 681, fig. 126n; Crosnier, 1976: 234, fig. 4a (in part).
Plesionika edwardsii: Crosnier & Forest, 1973: 202, figs 63b, 64b; Chace, 1985: 62, fig. 26f–g (part); Kensley, Tranter & Griffin, 1987: 314–315; Chan & Yu, 1991: 550, figs 2, 3b; Chan & Crosnier, 1997: 193, fig. 23; Davie, 2002: 348.

MATERIAL. QMW15929, 42 ♂♂ (17.8–24.2mm), 5 ovig. ♀♀ (21.7–24.6mm), 1 juvenile, off Lihou Reef, Coral Sea, NE Qld, 600m, M.V. *Ocean Rover*, R. McAllister, Jun. 1989.

REMARKS. This species is very closely related to *Plesionika crosnieri*, and the points of difference are discussed under that species.

FIG. 3. *Plesionika grahami* Kensley et al., 1987. anterior carapace, lateral view, W11404, scale = 5mm.

DISTRIBUTION. Mediterranean, Atlantic, Indo-Pacific; 50–680m; previously recorded from Australia between Point Danger, SE Qld, and Batemans Bay, NSW.

Plesionika grahami Kensley, Tranter & Griffin, 1987 (Fig. 3)

Plesionika grahami Kensley, Tranter & Griffin, 1987: 315, figs 20, 21; Davie, 2002: 348.

MATERIAL. QMW11404, 2 ♀♀ (26.6, 27.2mm), 23°07'S, 153°24'E, 400m, *Southern Intruder*, trawled, M. Dredge (QFS), 6.09.1983; QMW26747, 4 ♂♂ (20.0–25.8mm), 4 ♀♀ (20.6–30.0mm), 2 ovig. ♀♀ (25.4, 25.5mm), 23°28'S, 153°00'E, 110m, *Southern Intruder*, off Burnett Heads, shot 57; QMW26742, ♂ (16.4mm), 27°13'–27°22'S, 153°53'E, 500–540m, *Iron Summer*, trawled, 2–3.10.1982; QMW26752, ovig. ♀ (24.0mm), 27°13'–27°22'S, 153°53'E, 500–540m, *Iron Summer*, trawled, shot 1–7, M. Holmes, 2–3.10.1982; QMW26753, ♀ (16.4mm), 28°04'S, 153°57'E, 400m, *Iron Summer*, trawled, shot 3, P. Dutton, 28.07.1982; QMW26751, ♂ (16.5mm), 28°04'S, 153°57'E, 400m, *Iron Summer*, trawled, shot 3, P. Dutton, 28.07.1982; QMW26745, ♀ (25.4mm), 27°54.5'S, 153°59'E, 490m, *Iron Summer*, shot 6, S. Hyland, 30.11.1982.

REMARKS. *Plesionika grahami* is most closely related to members of the *Plesionika rostricrescentis* species-group from which it can be readily distinguished by its strongly curved and deep rostrum, that bears more than 18 closely set, long, acute ventral teeth, but which is unarmed dorsally for the larger part of its distal margin, ending only in a couple of subapical teeth. Our material agrees with the original description except for the following variations. 1) The specimens reach a larger size — the largest female has a postorbital carapace length of 30.0mm. 2) The rostrum is deeper, and always has 7 proximal dorsal teeth and 2 subapical teeth. 3) The rostral movable crest spines vary from 1–3. 4) The telson is about 1.4 times as long as the sixth abdominal somite. 5) Right second pereiopod with 25–27 carpal articles. 6) Left second perciopod with 109–125 carpal articles, about 60 meral articles, and the distal one-third of the ischium also feebly sub-segmented into about 13 articles. 7) Dactylus of third perciopod about 0.2 times as long as propodus; with an accessory distal spine about 0.7 times as long as the main terminal spine; with the proximal 3/5 of the opposable margin of the accessory distal spine setose, and in close contact with the main terminal spine; the proximal 2/5 of the flexor margin of the dactyl bearing four accessory spines, becoming larger distally.

DISTRIBUTION. Previously known only from New South Wales, Australia. The present records extend the range northward to 23°07'S. Bathymetric range: from 149–675m (Kensley et al., 1987), but present records from as shallow as 110m.

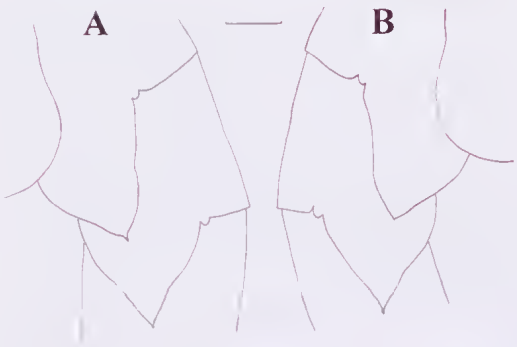


FIG. 4. *Plesionika grandis* Doflein, 1902, fourth and fifth abdominal somite, lateral view, QMW10081, ovig. female. A, left side; B, right side, scale = 2mm.

Plesionika grandis Doflein, 1902
(Fig. 4)

Plesionika spinipes var. *grandis* Doflein, 1902: 618, pl. 3 figs 3–5.
Parapandalus spinipes: De Man, 1920: 108, 142, pl. 12: fig. 33a, c–e; pl. 13: fig. 33, 33b [not *Plesionika spinipes* (Bate, 1888)].
Plesionika grandis: Chace, 1985: 66, figs 28, 29: Hayashi, 1986: 132, 133, 271, fig. 83; Hanamura & Takeda, 1987: 110; Chan & Crosnier, 1991: 423, figs 3f, 22; Davie, 2002: 349; Li & Komai, 2003: 260–261.

MATERIAL. QMW10081, 2 ♂♂ (?12.8, 15.6mm), 4 ovig. ♀♀ (14.6–15.3mm), 22°51.7'S, 152°45.7'E, 261m, *Craigmin* Survey, Stn 22, QFS, 3.10.1980; QMW10080, 7 ♂♂ (14.5–17.5mm), 10 ovig. ♀♀ (16.0–17.6mm), 22°51.7'S, 152°45.7'E, 261m, *Craigmin* Survey, Stn 22, QFS, 3.10.1980; QMW10082, ovig. ♀ (14.4mm), 23°36.3'S, 152°43.2'E, 360m, *Craigmin* Survey, Stn 19, QFS, 30.09.1980; QMW10084, 1 specimen (damaged, 14.6mm), 23°36.3'S, 152°43.2'E, 360m, *Craigmin* Survey, Stn 19, QFS, 30.09.1980; QMW10083, ♂ (15.5mm), 9 ovig. ♀♀ (15.2–18.7mm), 23°50.6'S, 152°36.2'E, 270m, *Craigmin* Survey, Stn 15, QFS, 29.09.1980; QMW10070, ovig. ♀ (14.4mm), 23°36.3'S, 152°43.2'E, 360m, *Craigmin* Survey, Stn 19, QFS, 30.09.1980; QMW28059, 2 ovig. ♀♀ (17.0, 18.8mm), 23°34'S, 153°16'E, 650m, *Southern Intruder*, shot 5, M. Dredge (QFS), 9.08.1983; QMW20867, 2 ♂♂ (17.0, 17.3mm), ovig. ♀ (19.9mm), 18°14.6'S, 118°11.2'E, North West Shelf, WA, 267m, R.V. *Southern Surveyor*, Stn 123, S. Cook, 8.09.1995; QMW16218, 2 ovig. ♀♀ (17.0, 17.5mm), 16°55'S, 150°00'E, near Chilcott Island, Qld Plateau, NE Qld, 406m, *Valkyrie Voyager*, trawled, B. Williams, 3.07.1989; QMW26760, ♂ (18.5mm), 7 ovig. ♀♀ (15.3–19.4mm), 23°59'S, 152°59'E, 380m, *Southern Intruder* Survey, shot 1, M. Dredge (Q.F.S), 8.08.1983.

REMARKS. *Plesionika grandis* is a member of the *Plesionika narval* species-group revised by Chan & Crosnier (1991). These species have a very long rostrum armed with numerous closely set teeth along almost the entire length of both margins. Interestingly, sometimes the posteroventral angle of the fourth abdominal somite of *P. grandis* is more acute on the left side than on the right (compare Figs 4A, B). This is evident in the present material of *P. grandis*, but also on specimens of *P. narval* (Fabricius, 1787) found by the first author from the northern South China Sea.

DISTRIBUTION. Widespread Indo-west Pacific (Madagascar to southern Japan, Taiwan, Philippines). Previously only reported from NW Australia, so present material represents a new distributional record for Queensland and the SW Pacific. Bathymetric range: 110–375m.

Plesionika indica De Man, 1917

Plesionika longipes var. *indica* De Man, 1917: 279; 1920: 106, 121, pl. 10, fig. 25a–g, pl. 11: fig. 25.
Plesionika sindoi: Balss, 1925: 279, figs 49–52, pl. 26.
Plesionika indica: Calman, 1939: 198; Chace, 1985: 70, figs 31, 32; Hanamura & Takeda, 1987: 111; Hanamura & Evans, 1996: 12; Davie, 2002: 349; Li & Komai, 2003: 261.

MATERIAL. QMW15837, ovig. ♀ (27.3mm), 16°41'S, 146°15'E, 600m, off Euston Reef, NE Qld, trawled, 2.12.1986.

REMARKS. Although represented by only a single ovigerous female the following characters are diagnostic for *Plesionika indica*: 1) the large adult size; 2) rostrum with 4 small dorsal teeth behind the level of the postorbital margin; 3) telson 1.6 times as long as the sixth abdominal somite; 4) the four anterior pairs of pereiopods with well-developed epipods; 5) second pereiopods with 38 carpal articles. The present record extends the bathymetric range to 600m depth.

DISTRIBUTION. Eastern Africa off Zanzibar, Indonesia, South China Sea, Philippines, Japan, Australia. Previously only reported from NW Australia, so the present specimen represents a new distributional record for Queensland and the SW Pacific. Bathymetric range: 220–600m.

Plesionika izumiae Omori, 1971

Plesionika izumiae Omori, 1971: 242, figs 1, 2; Hayashi, 1986: 132, 133, 271, fig. 84; Li & Komai, 2003: 261–262.
Plesionika izumiae ?: Chace, 1985: 75, fig. 34.

MATERIAL. QMW26748, ♀ (9.8mm), 17°47'S 146°54'E to 17°45'S 146°52'E, 296–300m, *Soela*, Cr. 6, Stn 50, P. Davie, 30.11.1985.

REMARKS. *Plesionika izumiae* has been found from the East China Sea and northern part of the South China Sea and adjacent areas (Li & Komai, 2003), where it could be considered a common pandalid species. The present single female specimen from off Queensland is a significant south-easterly range extension for this species.

DISTRIBUTION. New Australian record. Previously known from Japan, the northern part of the South China Sea, and the Philippines. Bathymetric range: 22–300m.

Plesionika narval (Fabricius, 1787)

Astacus Narval Fabricius, 1787: 331.
Parapandalus narval: Crosnier & Forest, 1973: 221, fig. 69a; Crosnier, 1976: 235, fig. 4b.
Plesionika serratifrons: De Man, 1920: 146, pl. 12, fig. 34a, c, pl. 13, fig. 34b, d, e; Chace, 1985: 121, figs 55, 56 (not Borradaile, 1900).
Plesionika narval: Lemaitre & Gore, 1988: 385, figs 3k–m, 4; Chan & Crosnier, 1991: 443, figs 12a–c, 13a, 14a–c, 15a–e, 34–36; Li & Komai, 2003: 265–267; Fransen, 2006: 71-73, figs. 20, 66.

MATERIAL. QMW10465, ovig. ♀ (17.6mm), off Cape Moreton, SE Qld, 110–119m, trawled, D. Harris, 30.03.1969; QMW7211, 2 ovig. ♀♀ (16.2, 16.5mm), off Cape Moreton, Moreton Bay, SE Qld, 110m, trawled, CSIRO, 13.08.1970; QMW28060, ♀ (16.6mm), 17°58.7'S, 147°08.7'E, off Tully, Qld, 325–328m, continental slope, R.V. *Soela*, C0685A91, trawled, CSIRO, 9.12.1985; QMW3157, ♂ (17.3mm), ♀ (21.1mm), 14 ovig. ♀♀ (16.0, 21.0mm), Cape Moreton, 119–128m, 20.03.1969; QMW4687, ovig. ♀ (15.0mm), NW off Cape Moreton, 110m, R. J. McKay, 27.02.1975; QMW26759, ♂ (16.8mm), ♀ (19.5mm), C61, shot 32, 327m, 21°57'S, 153°25'E, 330m, *Southern Intruder* Survey, M. Dredge (Q.F.S), 2.11.1983.

DISTRIBUTION. Mediterranean, Eastern Atlantic, South Atlantic, Indo-West Pacific from Red Sea, and Madagascar to French Polynesia. This is the first Australian record for this species. Bathymetric range: 70–910m.

Plesionika orientalis Chace, 1985

Plesionika martia orientalis Chace, 1985: 84, figs 38, 39, 53, 54; Hanamura & Takeda, 1987: 111, fig. 3a, b; Takeda & Hanamura, 1994: 21, fig. 9.
Plesionika orientalis: Hanamura & Evans, 1996: 14; Davie, 2002: 350.

MATERIAL. QMW11297, ♂ (23.7mm), ♀ (20.2mm), 5 ovig. ♀♀ (18.5–26.2mm), 23°17'S, 153°56'E, 460m, *Southern Intruder*, Shot 40, P. Davie, 30.11.1983.

REMARKS. The specimens agree closely with the original description of Chace (1985). The species is very close to *P. semilaevis* Bate, 1888. It differs from the latter by having the post-orbital margin nearly vertical, and the exopod of the third pleopod long, more than 0.75 times as long as the carapace, and the basicerite with distoventral tooth small and short, distinguishable from that of *P. martia* (A. Milne Edwards, 1883) and *P. semilaevis* Bate, 1888, whose distoventral teeth of the basicerite are very long and strong.

DISTRIBUTION. Australia, Indonesia–Philippines region. Within Australia previously only reported from off NW Australia, so the present specimen represents a new distributional record for Queensland and eastern Australia. Bathymetric range: 247–686m.

Plesionika parvimartia Chace, 1985

Plesionika parvimartia Chace, 1985: 93, fig. 42, 43; Davie, 2002: 350.

MATERIAL. QMW20866, 3 ovig. ♀♀ (14.8, 16.0, 16.3mm), 18°14.6'S, 118°11.2'E, North West Shelf, WA, 267m, R.V. *Southern Surveyor*, Stn 123, S. Cook, 8.09.1995; QMW20871, 2 ovig. ♀♀ (15.5, 16.3mm), 18°38.7'S, 118°07.0'E, North West Shelf, WA, 150m, R.V. *Southern Surveyor*, Stn 122, S. Cook, 8.09.1995; QMW26775, ♂ (6.5mm), 18°00.1'S 147°05.0'E, CSIRO, Cr. 0186, Stn 68, 300m, 20.01.1986.

REMARKS. The specimens agree closely with the original description of Chace (1985), they are bigger than Chace's (1985) material (his material with the maximum carapace length is 15mm). *Plesionika parvimartia* differs from the other members of *P. martia* species group by the anteriormost tooth of dorsal rostral series arising anterior to distal end of antennular pedunele, and probably, the relative small body size.

DISTRIBUTION. Australia, Indonesia, Philippines. Within Australia previously only reported from off NW Australia, so the present specimen represents a new distributional record for Queensland and eastern Australia. Bathymetric range: 176–366m.

Plesionika reflexa Chace, 1985
(Fig. 5)

Plesionika reflexa Chace, 1985: 108, fig. 49; Hayashi, 1986: 136, 137, 273, fig. 88; Crosnier, 1986: 362; Kensley, Tranter & Griffin, 1987: 318; Hanamura & Takeda, 1987: 116; Takeda & Hanamura, 1994: 23, fig. 10; Poupin, 1996: pl. 5a; Chan & Crosnier, 1997: 194, figs 3, 24; Davie, 2002: 350; Fransen, 2006: 77, 78, fig. 23.

MATERIAL. QMW11411, ovig. ♀ (20.0mm), 23°15'S, 153°45'E, 415m, *Southern Intruder*, trawled, shot 3, M. Dredge (QFS), 6.09.1983; QMW11465, ovig. ♀ (20.3mm), 23°46'S, 153°06'E, 550m, *Southern Intruder*, trawled, shot 3, M. Dredge (QFS), 9.08.1983; QMW11296, 2 ovig. ♀♀ (18.2, 19.3mm), 23°21'S,

153°23'E, 410m, *Southern Intruder*, trawled, shot 41, P. Davie, 30.11.1983; QMW11321, 2 ♂♂ (20.0mm), 23°22'S, 152°45'E, 350–310m, *Southern Intruder*, trawled, shot 42, P. Davie, 30.11.1983; QMW11284, ♂ (16.3mm), ovig. ♀ (20.9mm), 2 specimens (abdomen damaged, 15.9, 18.9mm), 23°54'S, 153°01'E, 465m, *Southern Intruder*, trawled, shot 1, P. Davie, 29.11.1983; QMW10673, ♂ (20.3mm), 23°28'S, 153°19'E, 562m, *Craigmin* Survey, Stn 6, trawled, QFS, 20.09.1983; QMW28061, ♂ (18.1mm), 23°30'S, 153°04'E, 540m, *Craigmin* Survey, Stn 7, trawled, QFS, 20.09.1980; QMW28062, ♂ (19.5mm), 22°36.7'S, 154°14.0'E, 522m, *Craigmin* Survey, Stn 25, QFS, 4.10.1980; QMW10086, 2 ♀♀ (14.4, 19.6mm), 23°30'S, 153°04'E, 540m, *Craigmin* Survey, Stn 7, QFS, 20.09.1980; QMW11223, ♀ (14.2mm), 9°52'S 144°26'E–9°53'S 144°23'E, east of Murray Isles, 480m, QFS 'G. May', 28.05.1983; QMW26761, ovig. female (20.8mm), 27°36'S, 153°36'E, SE Qld, 540m, M.V. *Iron Summer*, trawled, shot 6, P. Dutton, 29.07.1982; QMW26764, ovig. ♀ (20.2mm), 23°52'S, 153°02'E, 650m, *Southern Intruder*, trawled, shot 37, M. Dredge (QFS), 29.11.1983.

REMARKS. *Plesionika reflexa* is very close to *P. ensis* (A. Milne Edwards, 1881). According to Chace (1985), the main difference between the two forms is the posteromesial tooth on the third abdominal somite: it is reflexed dorsally in *P. reflexa* but nearly straight to recurved ventrally in *P. ensis*. Other differences are less reliable. 1) In *P. reflexa* the dactyl of the third pereiopod is typically longer than in *P. ensis*, being more than 0.25 times as long as the propodus (although Chace (1985) and Chan & Crosnier (1997) indicated that this ratio is highly variable and can range from 0.17–0.40), versus less than 0.25 times as long as propodus. 2) In *P. reflexa* the accessory distal spine on the dactyl of the third pereiopod is less than 0.25 times as long as the main terminal spine (unguis), and close to the base, whereas in *P. ensis* it is more than 0.25 as long as main terminal spine and usually more distant from the base. 3) the distolateral tooth on the antennal scale does not project as far distally in *P. reflexa* as it does in *P. ensis*.

The colouration of the two species, as shown in Chan & Crosnier (1997: figs 24, 25), is very similar, although *P. reflexa* appears more reddish than *P. ensis*.

We have based our identification on the following observations of our specimens. The posteromesial tooth on the third abdominal somite tends to recurve dorsally (Fig. 5C), although one (W11465) is straight (Fig. 5E); the dactyl of the available third pereiopods is 0.25–0.29 times as long as the propodus (Fig. 5F), the distolateral tooth on the antennal scale is less prominent (Fig. 5B), but closer to Chace's figure of *P. reflexa* (1985: fig. 49f) than to his figure of *P. ensis* (1985: fig. 50c). The accessory distal spine of the dactyl on available ambulatory pereiopods is 0.30–0.34 times as long as the propodus (Fig. 5I), which differs from the description and illustration of Chace (1985), however the illustration of Chan & Crosnier (1997: fig. 3b) based on French Polynesian material also shows a specimen with a long accessory spine on the dactyl of the third pereiopod. The rostrums of all our specimens are broken; the specimen with the longest rostrum (W10673) has 5 dorsal teeth at the base of the rostrum and 28 ventral teeth.

DISTRIBUTION. Probably widely distributed in the Indo-Pacific; bathymetric range 191–910m (Chan & Crosnier, 1997).

Plesionika semilaevis Bate, 1888

Plesionika semilaevis Bate, 1888: 644, pl. 68, fig. 3; Chace, 1985: 113, figs 51–54; Hanamura & Takeda, 1987: 116, fig. 3c, d; Ohtomi & Hayashi, 1995: 1035, fig. 1; Chan & Crosnier, 1997: 213; Davie, 2002: 350; Li & Komai, 2003: 268.

Plesionika martia var. *semilaevis*: De Man, 1920: 116 (in part).

MATERIAL. QMW10066, 3 ♂♂ (18.5, 18.5, 19.2mm), 2 ovig. ♀♀ (18.1, 19.2mm), 23°15.3'S, 154°21.7'E, 549m, *Craigmin* Survey, Stn 26, QFS, 4.10.1980; QMW10078, 8 ovig. ♀♀ (16.2–18.2mm), 23°15.3'S, 154°21.7'E, 549m, *Craigmin* Survey, Stn 26, QFS, 4.10.1980; QMW10071, 3 ovig. ♀♀ (17.3, 18.1, 19.2mm), 23°15.3'S, 154°21.7'E, 549m, *Craigmin* Survey, Stn 26, QFS, 4.10.1980; QMW10073, 1 specimen (damaged, 17.0mm), 2 pieces of abdomen, 23°28'S, 153°19'E, 562m, *Craigmin* Survey, Stn 6, shot 3, QFS, 20.09.1980; QMW10072, 2 ♂♂ (14.4, 15.5mm), 7 ovig. ♀♀ (14.6–19.6mm), 23°11'S, 153°00'E, 420m, *Craigmin* Survey, Stn 8, shot 2, QFS, 20.09.1980; QMW10076, 9 ovig. ♀♀ (damaged, (available) 15.3–19.7mm), 23°28'S, 153°19'E, 562m, *Craigmin* Survey, Stn 6, QFS, 20.09.1980; QMW10079, 3 ovig. ♀♀ (15.8, 18.0, 18.7mm), 23°30'S, 153°04'E, 540m, *Craigmin* Survey, Stn 7, trawled, QFS, 20.09.1980; QMW10069, 3 ovig. ♀♀ (16.7, 17.5, 20.0mm), 3 specimens (damaged), 23°28'S, 153°19'E, 562m, *Craigmin* Survey, Stn 6, QFS, 20.09.1980; QMW10065, 2 ♂♂ (15.5, 17.8mm), 3 ovig. ♀♀ (16.5, 18.5, 19.2mm), 23°28'S, 153°19'E, 562m, *Craigmin* Survey, Stn 6, shot 3, QFS, 20.09.1980; QMW10068, ovig. ♀ (18.1mm), 22°36.7'S, 154°14.0'E, 522m, *Craigmin* Survey, Stn 25, QFS, 4.10.1980; QMW10074, 6 ♂♂ (17.0–19.0mm), 5 ovig. ♀♀ (17.0–18.7mm), 22°36.7'S, 154°14.0'E, 522m, *Craigmin* Survey, Stn 25, QFS, 4.10.1980; QMW10075, 2 specimens (damaged), 22°10'S, 154°10'E, 570m, *Craigmin* Survey, Stn 9, QFS, 21.09.1980; QMW28051, ovig. ♀ (18.3mm), 23°15'S, 153°45'E, 415m, *Southern Intruder*, trawled, shot 3, M. Dredge (QFS), 6.09.1983;

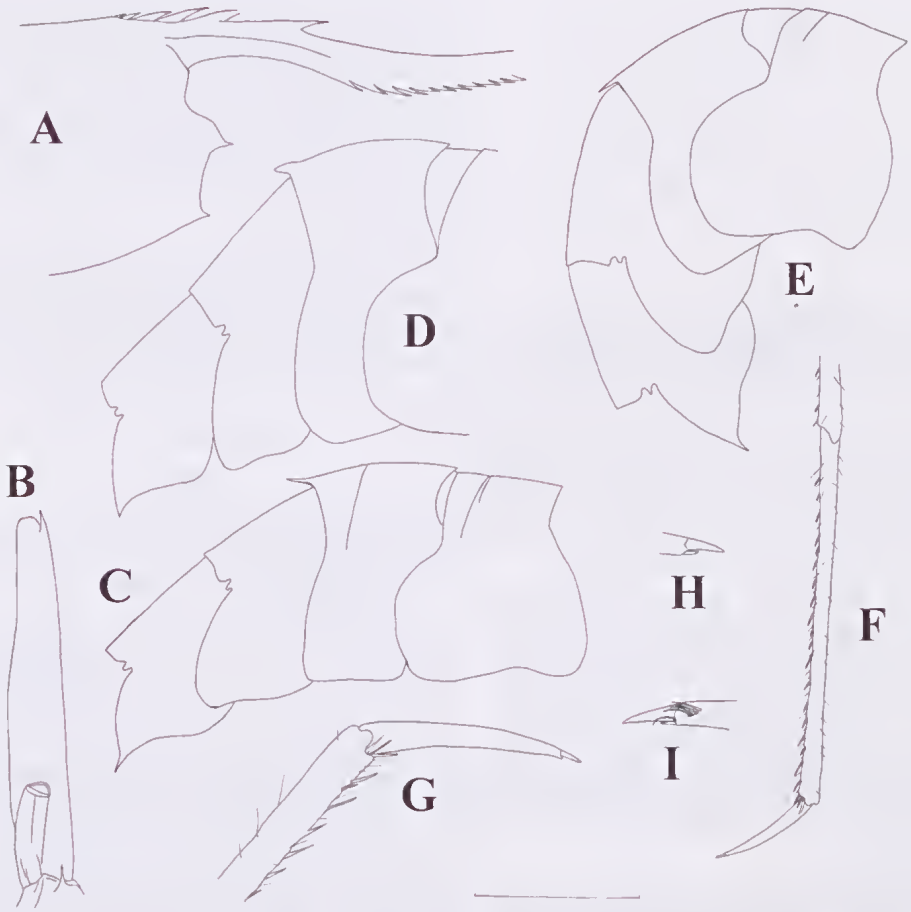


FIG. 5. *Plesionika reflexa* Chace, 1985. A, anterior carapace, lateral view; B, left scaphocerite, ventral view; C–E, second to fifth abdominal somites, lateral view; F, propodus and dactyl of left third pereiopod; G, same, dactyl and distal propodus; H, I, same, distal dactyl; A–C, F–H, QMW11411, ovig. female; D, QMW11321, male; E, I, QMW11465, ovig. female, scale = 8.5mm (A–E); 4mm (F); 2mm (G); 1mm (H, I).

QMW11410, ♀ (23.3mm), 3 ovig. ♀♀ (18.3mm), 23°34'S, 153°16'E, 650m, *Southern Intruder*, trawled, shot 5, M. Dredge (QFS), 9.08.1983; QMW11310, 3 male (15.5, 15.9, 17.2mm), 6 ovig. ♀♀ (16.0–19.6mm), 23°45'S, 153°07'E, 550m, *Southern Intruder*, trawled, shot 3, P. Davie, 29.11.1983; QMW11311, 2 male (16.0, 18.8mm), 4 ovig. ♀♀ (18.0–20.1mm), 23°52'S, 153°02'E, 650m, *Southern Intruder*, trawled, shot 2, P. Davie, 29.11.1983; QMW11289, 10 ovig. ♀♀ (15.2–19.3mm), 23°21'S, 153°23'E, 410m, *Southern Intruder*, trawled, shot 41, P. Davie, 30.11.1983; QMW11288, 7 ♂♂ (14.1–18.0mm), ♀ (19.1mm), 9 ovig. ♀♀ (15.5–18.4mm), 23°22'S, 152°45'E, 350–310m, *Southern Intruder*, trawled, shot 42, P. Davie, 30.11.1983; QMW18030, 2 ♂♂ (21.2, 22.2mm), 17°01.8'S, 151°20.1'E, off Cairns, Qld, 802–792m, R.V. *Soela*, trawled, CSIRO, 6.12.1985; QMW14914, 1 juvenile (14.8mm), 22°13.00'S, 153°52.53'E, M.V. *Iron Summer*, Shot 1, 590m, R. Morton, 9.05.1983; QMW16209, 2 ovig. ♀♀ (20.4, 21.0mm), 15°58'S, 149°56'E, 590m, M.V. *Valkyrie Voyager*, trawled, G. Williams, 30.06.1989; QMW26763, ♂ (16.2mm), 27°13' to 27°22'S, 153°00'E, SE Qld, 500–540m, M.V. *Iron Summer*, trawled, M. Holmes, 2–3.10.1982; QMW26739, 3 ♂♂ (14.7, 15.1, 15.4mm), ovig. ♀ (15.0mm), 27°45.6'S, 153°58'E, SE Qld, 540m, M.V. *Iron Summer*, trawled, shot 7, P. Dutton, 29.07.1982; QMW26740, ♂ (13.8mm), 27°18'S, 153°54'E, SE Qld, 540m, M.V. *Iron Summer*, trawled, shot 5, G. Smith and J. Burke, 13.08.1982; QMW26756, ♂ (14.1mm), ovig. ♀ (17.4mm), 27°36'S, 153°36'E, SE Qld, 540m, M.V. *Iron Summer*, trawled, shot 6, P. Dutton, 29.07.1982; QMW26757, ♂ (14.8mm), 27°55'S, 154°01'E, SE Qld, 555m, M.V. *Iron Summer*, trawled, shot 4, Q. F., 30.11.1982; QMW26754, ovig. ♀ (16.5mm), 27°59.37'S, 154°00.12'E, SE Qld, 590m, M.V. *Iron*

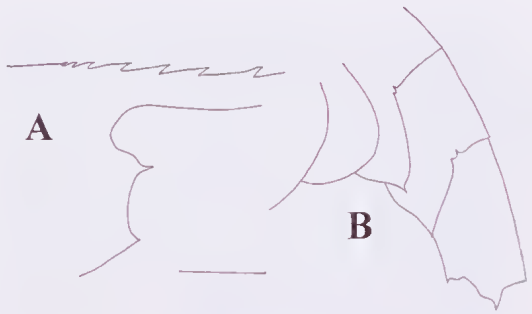


FIG. 6. *Plesionika* sp., QMW10086, ovig. female. A, anterior carapace, lateral view; B, fourth to sixth abdominal somites, lateral view, scale = 5mm.

Summer, trawled, shot 2, R. Morton, 31.03.1983; QMW26755, 3 ♂♂ (13.7, 15.3, 17.2mm), 28°01'S, 153°59'E, SE Qld, 550m, M.V. *Iron Summer*, trawled, shot 1, M. Potter, 1.08.1982; QMW26741, 2 ovig. ♀♀ (27.7, 28.4mm), 27°13' to 27°22'S, 153°53'E, 500–540m, M.V. *Iron Summer*, 2–3.10.1982.

REMARKS. *Plesionika semilaevis* belongs to the *P. martia* species-group (Forest and Holthuis, 1997) which can be difficult to identify. The present specimens have the posterior margin of the orbit noticeably inclined posterodorsally, and the exopods of the third pleopods relatively short (0.47–0.66 times as long as the carapace). These characters best match the definition of *P. semilaevis* by Chace (1985) and Hanamura & Takeda (1987).

DISTRIBUTION. Philippines, Indonesia, South and East China Seas, Japan and Australia. While not previously identified from Queensland waters, it has been recorded from further south off NSW. Bathymetric range: 176–700m.

Plesionika sindoi (Rathbun, 1906)

Pandalus sindoi Rathbun, 1906: 915, pl. 21, fig. 4.
Plesionika Sindoi: De Man, 1920: 126, pl. 11, fig. 27–27d, pl. 12, fig. 27e.
Plesionika ocellus: Chace, 1985: 90, fig. 40.
Plesionika sindoi: Poupin, 1996, pl. 5c; Chan & Crosnier, 1997: 216, figs 17, 36–37; Li & Komai, 2003: 268–269.

MATERIAL. QMW26743, 2 ♂♂ (12.0, 12.4mm), 3 ovig. ♀♀ (11.0, 13.4, 13.5mm), CSIRO Cr. 186, Stn 73, 20.01.1986; QMW26744, ♂ (10.9mm), CSIRO Cr. 186, Stn 55, 17.01.1986.

REMARKS. The present species is close to *P. ocellus* Bate, 1888, the important differenee between the two species is the posterolateral angle of the fourth abdominal somite, which is rounded in *P. sindoi* and denticulate in *P. ocellus*. In our material, 2 males and 2 ovigerous females have both sides rounded, 1 ovigerous female (cl. 11.0mm) has the right side rounded and the left side dentieulate, while another male (cl. 10.9mm) has both sides denticulate. It is not impossible that the two speeies are identical. Here we identify our material as *P. sindoi* as four of the six specimens have a denticulate posterolateral angle on both sides of the fourth abdominal somite.

DISTRIBUTION. Known with certainly from Japan, South China Sea, Philippines, Indonesia, Hawaii, French Polynesia and Australia. The present specimens represent a new Australian record. Bathymetric range: 122–800m.

Plesionika sp.
(Fig. 6)

MATERIAL. QMW10086, ovig. ♀ (17.2mm), 22°56.1'S, 152°32.2'E, 144m, *Craigmin* Survey, Stn 21, Shot 9, dredge, QFS, 3.10.1980.

REMARKS. The rostrum and telson of this specimen are damaged, and most of the pereiopods are missing. The rostrum has three small dorsal teeth arising behind the level of orbital margin, with a basal suture on the posteriormost tooth (Fig. 6A); the fourth and fifth abdominal somites have a marginal tooth on the pleuron (Fig. 6B); the anterior four pereiopods have epipods; the right second pereiopod is present and has 31 carpal articles. It looks most similar to *Plesionika binoculus* (Bate, 1888), but that species has 5 basally articulated dorsal rostral teeth behind the orbital margin. Additional material from this locality will be needed before an accurate identification can be made.

Procletes levicarina (Bate, 1888)

Dorodotes levicarina Bate, 1888: 680.
Procletes biangulatus Bate, 1888: 884
Heterocarpus (Heterocarpoides) levicarina: De Man, 1920: 110, 178, pl. 15, fig. 44–44f; Kemp, 1925: 275.
Heterocarpoides levicarina: Calman, 1939: 207; Holthuis, 1955: 126, fig. 88b; Chace, 1985: 16, figs 11, 12.
Heterocarpus (Heterocarpoides) glabrus Zarenkov, 1971: 193, figs 4 (16–27).
Heterocarpus (Procletes) levicarina Menon, 1972: 382, figs 4–10.
Procletes levicarina: Holthuis, 1993: 278, fig. 277; Davie, 2002: 351; Li & Komai, 2003: 271.

MATERIAL. QMW26773, ovig. ♀ (13.7mm), 18°07'S, 147°11'E, 250m, *Soela*, Stn 96, P. Davie, 9.12.1985; QMW26772, ovig. ♀ (12.4mm), 18°00.6'S 147°02.2'E, CSIRO, Cr. 0186, Stn 41, 216-220m, 15.01.1986.

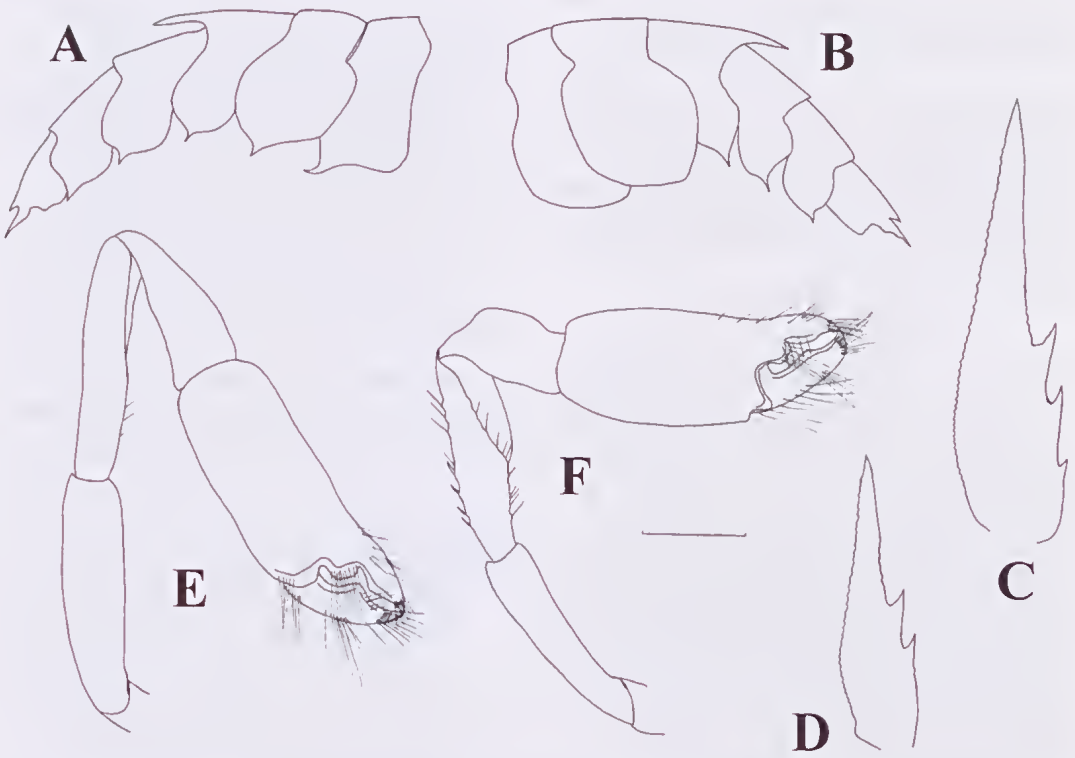


FIG. 7. *Thalassocaris crinita* (Dana, 1852a), A, B, abdomen, lateral view; C, D, right scaphocerite, dorsal view; E, F, right second pereiopod; A, C, E, QMW20717, female; B, F, QMW25845, male; D, QMW25858, male, scale = 2mm (A, B); 1mm (C–F).

DISTRIBUTION. Red Sea to Indonesia, South China Sea, Philippines, Australia and Japan. Bathymetric range: 14–393m.

Family Thalassocarididae

Thalassocaris crinita (Dana, 1852a)
(Fig. 7)

Regulus crinitus Dana, 1852a: 27; 1852b: 599; 1855: pl. 39: fig. 6a–h.

Thalassocaris crinita: Balss, 1914: 28; De Man, 1920: 95, pl. 9: figs 22–22o; Menon & Williamson, 1971: 33, figs 1b, 3, 5b, 6c, d, 10a, b, 11j–r, 13; Chace, 1985: 7, figs 3–5; Hanamura, 1987: 30, fig. 13; Davie, 2002: 380; Li & Komai, 2003: 258.

MATERIAL. QMW20726, ♂ (4.9mm), 16°45.5'S, 145°58.2'E, Green Island, NE Qld, sublittoral, 3m, seagrass (*Halodule univervis*, *Cymodocea serrulata*), sand/shell, Stn UNKN31, L. McKenzie, 27.03.1990; QMW20727, ♀ (5.3mm), 16°45.5'S, 145°58.2'E, Green Island, NE Qld, sublittoral, 3m, seagrass (*Halodule univervis*, *Cymodocea serrulata*), sand/shell, Stn UNKN31, L. McKenzie, 27.03.1990; QMW20728, ovig. ♀ (5.2mm), 16°45.5'S, 145°58.2'E, Green Island, NE Qld, sublittoral, 3m, seagrass (*Halodule univervis*, *Cymodocea serrulata*), sand/shell, Stn UNKN31, L. McKenzie, 27.03.1990; QMW20717, ♀ (5.2mm), 14°40'S, 145°28'E, Lizard Island, NE Qld, sublittoral, 3m, Stn UNKN31, netted, L. Squire, 3.12.1988; QMW25845, ♂ (5.6mm), 21°42.2'S, 151°44.3'E, Prong #2 Reef, Great Barrier Reef, ME Qld, Stn PR-2, 3–6m, SCUBA, coral cave with fine silt floor, J. Johnson, 11.03.2000; QMW25846, ♂ (5.5mm), 21°42.2'S, 151°44.3'E, Prong #2 Reef, Great Barrier Reef, ME Qld, Stn PR-2, 3–5m, SCUBA, cave, *Acropora*, J. Johnson and A. Gill, 11.03.2000; QMW25858, ♂ (3.2mm), 18°28'S, 146°52'E, Rib Reef off Townsville, NE Qld, Stn PR-2, 3–5m, light trap, 3m, S. Cook, RV *James Kirby*, 25.10.1998.

REMARKS. These specimens agree well with the descriptions of Menon & Williamson (1971) and Chace (1985), except that the pereiopods at most over-reach the rostrum only by the fingers. The shape of the abdominal pleura is distinctly sexually dimorphic: in males the pleura of the first to fifth abdominal somites are pointed (Fig. 7A), but in females those of the first and second abdominal somites are rounded (Fig. 7B).

The antennal scale typically has 3 lateral teeth (Fig. 7C), but one small, perhaps juvenile, male (QMW25858) has only 2 lateral teeth (Fig. 7D).

DISTRIBUTION. Red Sea to Indonesia, Philippines, Japan, Australia, Marshall Islands. Within Australia previously only reported from off NW Australia, so the present specimens represent a new distributional record for Queensland and eastern Australia. Bathymetric range: less than 100m.

ACKNOWLEDGEMENTS

The Scientific Cooperation Program of the Chinese Academy of Sciences and the Australian Academy of Science financially supported the first author's (X. Li) visit to the Queensland Museum, Brisbane in May to August 2003. Thanks are due to Drs T. Komai (Natural History Museum and Institute, Chiba) and Tin-Yam Chan (National Taiwan Ocean University, Keelung), for their kind answers to a number of the authors' questions. We also acknowledge Thierry Laperousaz, South Australian Museum, Adelaide, for promptly lending us some pandalid material held in that musem. Lastly we are indebted to Drs Sandy Bruce, Alain Crosnier, and Charles Fransen for helpful reviews and comments on the manuscript. The present study was partly supported by the National Natural Science Foundation of China (Nos. 30499340 and 40276044).

LITERATURE CITED

ALCOCK, A. 1901. A descriptive catalogue of the Indian Deep-Sea *Crustacea Decapoda Macrura* and *Anomala*, in the Indian Museum. Being a revised account of the deep-sea species collected by the Royal Indian Marine Survey Ship *Investigator*. (Alcock, A.: Calcutta).

ALCOCK, A. & ANDERSON, A.R. 1894. Natural history notes from H. M. Indian Marine Survey Steamer Investigator, Commander C. F. Oldham, R. N., commanding, Series II, 14: An account of a recent collection of deep sea Crustacea from the Bay of Bengal and Laccadive Sea. Journal of the Asiatic Society of Bengal 63(2): 141–185.

ALCOCK , A. & MCARDLE, A.F. 1901. Crustacea, Part IX. In, Illustrations of the Zoology of the Royal Indian Marine Survey Ship Investigator, under the Command of Commander T. H. Heming, R. N., (Calcutta).

ANDERSON, A.R.S. 1896. Natural history notes from R. I. M. Survey steamer "Investigator", Commander C. F. Oldham, R. N., Commanding, 21: An account of the deep sea Crustacea collected during the season 1894–95. Journal of the Asiatic Society of Bengal, series 2 65(2): 88–106.

BALSS, H. 1914. Ostasiatische Decapoda, II: Die Natantia und Reptantia. In: F. Doflein (ed.), Dekapoden Part 7 in volume 2 of Beitraege zur Naturgeschichte Ostasiens. Abhandlungen der Bayerishen Akademie der Wissenschaften, München, supplement. 2(10): 1–101.

1925. Macrura der Deutschen Tiefsee-Expedition, 2: Natantia (teil A). Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer Valdivia, 1898–1899 20(5): 217–315.

BARNARD, K.H. 1950. Descriptive catalogue of South African Decapoda Crustacea. Annals of the South African Museum 38: 1–837.

BATE, C.S. 1888. Report of the Crustacea Macrura collected by the Challenger during the years 1873–1876. Report on the scientific results of the voyage of H. M. S. Challenger during the years 1873–1876, 24: 1–942.

BORRADAILE, L.A. 1900. On the Stomatopoda and Macrura brought by Dr. Willey from the South Seas. In, Willey, A., Zoological results based on materials from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896 and 1897, 4: 395–428. (Cambridge University Press: Cambridge)

1915. Notes on Carides. Annals and Magazine of Natural History (8)15: 205–213.

1916. Crustacea, Part I: Decapoda. Natural History Reports, British Antarctic ("Terra Nova") Expedition, 1910 (Zoology) 3(2): 75–110.

1917. The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr. J. Stanley Gardiner, M. A., Vol. 6, IX: On Carides from the Western Indian Ocean. The Transactions of the Linnean Society of London (2)17(3): 397–412.

BRANDT, F. 1851. Krebse. In, von Middendorff A.T., Reise in den äussersten Norden und Osten Sibiriens wahrend der Jahre 1843 und 1844 mit allerhöchster Genehmigung auf Veranstaltung der Kaiserlichen Akademie der Wissenschaften zu St Petersburg ausgefuhrt und in Verbindung mit vielen Gelehrten herausgegeben 2(1): 77–148.

1976. A report on a small collection of shrimps from the Kenya National Marine Parks at Malindi, with notes on selected species. Zoologische Verhandelingen, Leiden, 145: 1-72.

1988. The shrimp fauna of a small tropical reef, the East Point Fish Reserve, Darwin. In, Hanley, J.R., Larson, H.K. & Miehie, M.G. (eds), Darwin Harbour, Proceedings of the Workshop on Research and Management held in Darwin, 2–3 September, 1987. A.N.U. North Australia Research Unit, Mangrove Monograph, 4: 226–245.

BRUCE, A.J. & COOMBES, K.E. 1997. An annotated checklist of the Caridea (Crustacea, Decapoda) of Darwin Harbour, with descriptions of three new species of *Periclimenes* Palaemonidae: Pontoniinae). Pp 301–337. In, Hanley, J.R., Caswell, G., Megirian, D. & Larson, H.K. (eds), Proceedings of the Sixth International Marine Biological Workshop. The marine fauna and flora of Darwin Harbour, Northern Territory, Australia. (Museums and Art Galleries of the Northern Territory and the Australian Marine Sciences Association: Darwin).

CALMAN, W.T. 1939. Crustacea: Caridea. The John Murray Expedition 1933–1934, Scientific Report 6(4): 183–224.

CHACE, F.A. Jr. 1985. The caridean shrimps (Crustacea: Decapoda) of the Albatross Philippine Expedition, 1907–1910, Part 3: families Thalassocaridiidae and Pandalidae. Smithsonian Contributions to Zoology 411: 1–143.

CHAN, T.-Y. & CHUANG, S-C. 2002. A new shrimp species of *Plesionika* Bate, 1888 with high basal rostral crest (Crustacea: Decapoda: Pandalidae) from Taiwan. Proceedings of the Biological Society of Washington 115(3): 611–615.

CHAN, T.-Y. & CROSNIER, A. 1991. Crustacea Decapoda: studies of the *Plesionika narval* (Fabricius, 1787) group (Pandalidae) with descriptions of six new species. In, A. Crosnier (ed.), Résultats des campagnes MUSORSTOM Vol. 9. Mémoires du Muséum national d'Histoire naturelle, Paris 152: 413–461.

1997. Crustacea Decapoda: deep-sea shrimps of the genus *Plesionika* Bate, 1888 (Pandalidae) from French Polynesia, with descriptions of five new species. In, A. Crosnier (ed.), Résultats des Campagnes MUSORSTOM Vol. 18. Mémoires du Muséum national d'Histoire naturelle, Paris 176: 187–234.

CHAN, T.-Y. & YU, H.-P. 1987. On the *Heterocarpus* shrimps (Crustacea: Decapoda: Pandalidae) from Taiwan. Bulletin of the Institute of Zoology, Academia Sinica 26: 53–60.

1991. Two similar species: *Plesionika edwardsii* (Brandt, 1851) and *Plesionika crosnieri*, new species (Crustacea: Decapoda: Pandalidae). Proceedings of the Biological Society of Washington 104(3): 545–555.

COSTA, A. 1871. Species del Genere *Pandalus* Rinvenute del Golfo di Napoli. Annuario del Museo zoologico della R. Universita di Napoli 6: 89-92.

CROSNIER, A. 1976. Données sur les Crustacés décapodes capturés par M Paul Guézé à l'île de la Réunion lors d'essais de Pêche en eau profonde. Travaux et Documents ORSTOM 47: 225–256.

1986. Crevettes de la famille des Pandalidae récoltées durant ces dernières années en Polynésie française. Description de *Plesionika chacei* et *P. carsini* spp. nov. Bulletin du Muséum national d'Histoire Naturelle, Paris, 4ème série, section A, 8(2): 361–377.

1988. Sur les *Heterocarpus* (Crustacea, Decapoda, Pandalidae) du sud-ouest de l'océan Indien. Remarques sur d'autres espèces ouest-pacifiques du genre et description de quatre taxa nouveaux. Bulletin du Muséum national d'Histoire Naturelle, Paris 4ème série, section A, 10(1): 57–103.

1999. Un *Heterocarpus* nouveau (Crustacea, Decapoda, Pandalidae) du Pacifique sud-ouest. Zoosystema 21(2): 345–351.

CROSNIER, A. & FOREST, J. 1973. Les crevettes profondes de l'Atlantique oriental tropical. Faune Tropicale (ORSTOM) 19: 1–409.

DANA, J.D. 1852a. Conspectus Crustaceorum quae in Orbis Terrarum circumnavigatione, Carolo Wilkes e Classe Republicae Foederatae Duce, lexit et descripsit. Proceedings of the Academy of Natural Sciences of Philadelphia 6: 10–28.

1852b. Crustacea, Part I. In, United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842, under the Command of Charles Wilkes, U. S. N., (Philadelphia) Vol. 13: 1–685.

1855. Crustacea. In, United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842, under the Command of Charles Wilkes, U. S. N., (Philadelphia) Atlas: 1–27.

DAVIE, P.J.F. 2002. Crustacea: Malacostraca: Phyllocarida, Hoplocarida, Eucarida (Part 1). In, Wells, A. & Houston, W.W.K. (eds), Zoological Catalogue of Australia. Vol. 19.3A. (CSIRO Publishing: Melbourne).

DE GRAVE, S. 2001. Caridean shrimps (Crustacea, Decapoda) from Hansa Bay, Papua New Guinea: Bresiliidae, Hippolytidae, Pandalidae, Pasiphaeidae, Processidae, Rhynchocinetidae, Stylodactylidae and Thalassocaridiidae. Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie 71: 45-52.

DE MAN, J.G. 1917. Diagnoses of new species of Macrurous decapod Crustacea from the Siboga-Expedition. Zoologische Mededeelingen Leiden 3(4): 279–284.

1920. The Decapoda of the Siboga Expedition, IV: families Pasiphaeidae, Stylodactylidae, Hoplophoridae, Nematocarcinidae, Thalassocaridae, Pandalidae, Psalidopodidae, Gnathophyllidae, Processidae, Glyphocrangonidae and Crangonidae. Siboga-Expeditie 39a^3: 1–318.

DOFLEIN, F. 1902. Ostasiatische Dekapoden. Abhandlungen der Bayerischen Akademie der Wissenschaften, Muenchen 21: 613–670.

FABRICIUS, J.C. 1787. Mantissa Insectorum sistens eorum species nuper detectas adiectis characteribus genericis, differentiis specificis,

Emendationibus, Observationibus. 1. Hafniae: Chist. Gottl. Proft.

FAXON, W. 1893. Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, Carried on by the U.S.Fish Commission Steamer "Albatross" during 1891, Lieut. Commander Z.L. Tanner, U.S.N. Commanding, VI: Preliminary description of new species of Crustacea. Bulletin of the Museum of Comparative Zoology, Harvard College 24(7): 149-220.

FIGUEIRA, A.J.G. 1957. Madeiran Decapod Crustaceans in the collection of the Museu Municipal do Funchal, Part I: On some interesting deep-sea prawns of the families Pasiphaeidae, Oplophoridae and Pandalidae. Boletim do Museu Municipal do Funchal 10: (25, 26): 22-51.

FOREST, J. & HOLTHUIS, L.B. (re-editors), 1997. A. Milne-Edwards (original author), 1883. Recueil de Figures de Crustacés nouveaux ou peu connus, 1883. Nouvelle édition en facsimilé avec des commentaires et annotations/New facsimile edition with comments and annotations. (Backhuys Publishers: Leiden).

FRANSEN, C.H.J.M. 2006. Pandalidae (Crustacea: Decapoda) of the *SONNE*, *VALDIVIA* and *METEOR* Expeditions 1977-1987 to the Red Sea and the Gulf of Aden. Senckenbergiana maritima 36(1): 51-82.

FRANSEN, C.H.J.M., HOLTHUIS, L.B. & ADEMA, J.P.H.M. 1997. Type-catalogue of the Decapoda Crustacea in the collections of the Nationaal Natuurhistorisch Museum, with appendices of pre-1900 collectors and material. Zoologische Verhandelingen 311: i–xvi, 1–344.

HALE, H.M. 1924. The flora and fauna of Nuyts Archipelago and the Investigator Group. No. 16. The Crustacea. Transactions and Proceedings of the Royal Society of South Australia 48: 67–73.

HALE, H.M. 1927. The Crustaceans of South Australia. (Harrison Weir: Adelaide). HANAMURA, Y. 1987, Caridean shrimps obtained by R.V. "Soela" from north-west Australia, with description of a new species of *Leptochela* (Crustacea: Decapoda: Pasiphaeidae). Beagle 4(1): 15–33.

HANAMURA, Y. & EVANS, D.R. 1996, Deepwater Caridean shrimps of the families Nematocarcinidae, Stylodactylidae, Pandalidae and Crangonidae (Crustacea: Decapoda) from Western Australia. Bulletin of Nansei National Fisheries Research Institute 29: 1–18.

HANAMURA, Y. & TAKEDA, M. 1987. Family Pandalidae (Crustacea, Decapoda, Caridea) collected by the R.V. "Soela" from the Northwest Australian Shelf. Bulletin of the National Science Museum, Series A (Zoology), 13(3) 1987: 103–121, figs 1–3.

HAYASHI, K.-I. 1986. Penaeoidea and Caridea. In, Baba, K., Hayashi K.I. & Toriyama, M. (Eds), Decapod Crustaceans from Continental Shelf and Slope around Japan. Japan Fisheries Resource Conservation Association, Tokyo, pp. 1–336, pls 1–176.

HAYASHI, K.-I. & MIYAKE, S. 1968. Three caridean shrimps associated with a medusa from Tanabe Bay, Japan. Publications of the Seto Marine Biological Laboratory 16(1): 10–19.

HOLTHUIS, L.B. 1947. The Hippolytidae and Rhynchocinetidae collected by the Siboga and Snellius Expeditions with remarks on other species. The Decapoda of the Siboga Expedition. Part IX. Siboga-Expeditie 39a[8]: 1–100, figs 1–15.

1950. Decapoda (K. IX) A. Natantia, Macrura Reptantia, Anomura en Stomatopoda. Fauna van Nederland 15: 1–166.

1955. The recent genera of the caridean and stenopodidean shrimps (Class Crustacea: Order Decapoda: Supersection Natantia) with keys for their determination. Zoologische Verhandelingen, Leiden 26: 1-157 pp.

1980. FAO species catalogue. Vol. 1. Shrimps and prawns of the world. An annotated catalogue of species of interest to fisheries. FAO Fisheries Synopsis No. 125, Vol. 1. FAO: Rome.

1993. The recent genera of the *caridean* and *stenopodidean* shrimps (Crustacea, Decapoda), with an appendix on the Order Amphionidacea. Nationaal Natuurhistorisch Museum: Leiden.

HOLTHUIS, L.B. 1995. Notes on Indo-West Pacific Crustacea Decapoda III to IX. IV. *Chlorotocella spinicaudus* (H. Milne Edwards, 1837) a senior synonym of *Chlototocella leptorhynchus* (Stimpson, 1860). Zoologische Mededelingen, Leiden 69(1–14): 139–151.

KEMP, S. 1925. Notes on Crustacea Decapoda in the Indian Museum, XVII: On various Caridea. Records of the Indian Museum 27(4): 249–343.

KENSLEY, B.F. 1969. Decapod Crustacea from the South-West Indian Ocean. Annals of the South African Museum 52(7): 149–181.

KENSLEY, B.F., TRANTER, H.A. & GRIFFIN, D.J.G. 1987. Deepwater decapod Crustacea from eastern Australia (Penaeidea and Caridea). Records of the Australian Museum 39: 263–331.

KOMAI, T. 1991. Deep-sea decapod crustaceans from the Pacific coast of eastern Hokkaido, northern Japan (Crustacea, Decapoda, Penacidae and Caridea). Reports of North Japan Sub-committee for Bottom Fish 24: 55–96.

1995. Shrimps and lobsters. Pp 237–266. In, Okamura, O. et al. (eds) fishes collected by the R/V Shinkai Maru around Greenland. (Japan Marine Fishery Resources Research Center : Tokyo).

1999. A revision of the genus *Pandalus* (Crustacea: Decapoda: Caridea: Pandalidae). Journal of Natural History 33: 1265–1372.

LEDOYER, M. 1969. Les Caridea de la frondaison des herbiers de phanérogames de la région de Tuléar (République Malgache). Étude systématique et écologique. Recueil des Travaux de la station marine d'Endoume, Supplement, 8: 63-115.

1984. Les Caridea (Crustacea: Decapoda) des herbiers de phanérogames marines de Nouvelle-Calédonie (Région de Nouméa). Zoologische Verhandelingen, Leiden 211: 1–58.

LEMAITRE R. & GORE, R.H. 1988. Redescription, ecological observations, and distribution of the caridean shrimp *Plesionika escatilis* (Stimpson, 1860) (Decapoda, Pandalidae). Proceedings of the Biological Society of Washington 101(2): 382–390.

LI, X. & KOMAI, T. 2003. Pandaloid Shrimps from the Northern South China Sea, with Description of a New Species of *Plesionika* (Crustacea: Decapoda: Caridea). The Raffles Bulletin of Zoology 51(2): 257–275.

MENON, P.G. 1972. Decapod Crustacea from the International Indian Ocean Expedition: the Larval Development of *Heterocarpus* (Caridea). Journal of Zoology 167: 371–397.

MENON, P.G. & WILLIAMSON, D.I. 1972. Decapod Crustacea from the International Indian Ocean Expedition: The species of *Thalassocaris* (Caridea) and their larvae. Journal of Zoology 165: 27–51.

MILNE-EDWARDS, A. 1881. Description de quelques Crustacés Macroures provenant des grandes profondeurs de la mer des Antilles. Annales des Sciences Naturelles, Zoologie, series 6 11(4): 1–16.

1883. see Forest, J. & Holthuis, L. B. (re-editors), 1997.

MILNE EDWARDS, H. 1837. Histoire Naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux 2: 1–532. (Roret: Paris).

MONOD, T. 1973. Sur quelques Crustacés néo-calédoniens de profondeur. Cahiers ORSTOM, série Océanographie 11(2): 117–131.

NOBILI, G. 1904. Diagnoses préliminaires de vingt-huit espèces nouvelles de Stomatopodes et Décapodes Macroures de la mer Rouge. Bulletin de Muséum d'Histoire Naturelle, Paris 10(5): 228–238.

1906. Faune carcinologique de la Mer Rouge. Décapodes et Stomatopodes. Annales de Sciences Naturelles, Zoologie. Ser. 9, 4: 1–347.

OHTOMI J. & HAYASHI, K.-I. 1995. Some morphological characters of the deep-water shrimp *Plesionika semilaevis* from Kagoshima Bay, southern Japan (Crustacea, Decapoda, Caridea). Fisheries Science 61(6): 1035–1036.

OMORI, M. 1971. Taxonomy and some notes on the biology of a new caridean shrimp, *Plesionika izumiae* (Decapoda, Pandalidae). Crustaceana 20(3): 241–256, pl. 1.

ORTMANN, A.E. 1890. Die Unterordnung Natantia Boas. Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei der Liu-Kiu-Inseln gesammelten und z.Z. im Strassburger Museum aufbewahrten Formen. I. Zoologische Jahrbücher Abteilung für Systematik, Geographie und Biologie der Thiere 5: 437–542.

POUPIN, J. 1996. Atlas des Crustacés marinsprofonds de Polynésie Française. Récoltes du navire Marara (1986/1996). (Service Mixte de Surveillance Radiologique et Biologique: France).

RATHBUN, M.J. 1906. The Brachyura and Macrura of the Hawaiian Islands. Bulletin of the United States Fish Commission (1903) 23(3): 827–930.

SMITH, S.I. 1880. The stalk-eyed Crustaceans of the Atlantic coast of North America north of Cape Cod. Transactions of the Connecticut Academy of Arts and Sciences 5(1): 27–138.

STIMPSON, W. 1860. Crustacea Macrura. Pars VIII of Prodromus descriptionis animalium evertebratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. Proceedings of the Academy of Natural Sciences of Philadelphia Pp. 22–47.

SUZUKI, H. 1976. Two Pandalidae (Crustacea, Caridea) from Sagami Bay. Researches on Crustacea, 7: 41–51.

TAKEDA, M. & HANAMURA, Y. 1994. Deep-sea shrimps and lobsters from the Flores Sea collected by the R.V. Hakuho-Maru during KH-85-1 cruise. Bulletin of the National Science Museum, Series A (Zoology) 20(1): 1–37.

WILLIAMS, A.B. 1984. Shrimps, lobsters, and crabs of the Atlantic Coast of the eastern United States, Maine to Florida. (Smithsonian Institution Press: Washington).

ZARENKOV, N.A. 1971. Contribution to the study of the species and of the geographie distribution of the marine shrimps belonging to the families Hippolytidae and Pandalidae (Crustacea Decapoda). Complexnie Issledovaniia Prirodi Okeana, Moskovskogo Universiteta 2: 176–195. (In Russian)

REVIEW OF AUSTRALIAN SPECIES OF *PERITROPIS* (INSECTA: HETEROPTERA: MIRIDAE: CYLAPINAE)

TIMOTHY MOULDS AND GERASIMOS CASSIS

Moulds, T. & Cassis, G. 2006 11 10: A review of Australian species of *Peritropis* (Inseeta: Hetcroptera: Miridae: Cylapinae). *Memoirs of the Queensland Museum* **52**(1): 171-190. Brisbane. ISSN 0079-8835.

Six new species of *Peritropis* Uhler are deseribed from Australia: *adusta*, *albaspeeea*, *basseti*, *phalaroptera*, *postlei* and *roebueki* spp nov. The male and female genitalia are illustrated and an identifieation key is provided. The distribution of three Pacifie and Papua New Guinea species (*aotearoae*, *novoealedonieus* and *punetatus*) is extended to include Australia and Christmas Island. ❐ *Miridae, Cylapinae, Peritropis, Australia, new speeies, taxonomy.*

Timothy Moulds (e-mail: timothy.moulds@adelaide.edu), Australian Museum, 6 College Street, Sydney 2010; Centre for Evolutionary Biology and Biodiversity, School of Earth and Environmental Scienees, University of Adelaide, North Terraee, Adelaide 5005; Gerasimos Cassis, Australian Museum, 6 College Street, Sydney 2010; *15 November 2005.*

Apart from the ubiquitous genus *Fulvius* Stål, *Peritropis* Uhler is the most speeiose genus of the basal mirid subfamily Cylapinae. It has a eosmopolitan distribution, with 62 speeies eurrently deseribed (Sehuh, 1995; http://researeh.amnh.org/pbi/eatalog/; Table 1). The type speeies, *saldaeformis* Uhler, was deseribed from the United States. However, most of the speeies are found in the Eastern Hemisphere.

Despite the laek of definition of most of eylapine genera in a phylogenetie eontext, speeies of *Peritropis* have a eharaeteristie body form, with a small size, porreet head, enlarged eyes, and mottled body. Schmitz (1970) overviewed the concept of the genus, and made the following diagnostie remarks that we eonsider signifieant: 1, last antennal segment is secondarily divided, giving a five segmented appearanee; 2, parameres subequal in size; 3, male aedeagus bilobed with two spieules; and, 4, selerotised rings 'buekled'. Gorezyea (2000), in revising the Afrotropieal speeies of *Peritropis*, added that the labium minimally attains the metaeoxae, the pronotal eollar is greatly reduced to absent, and the tarsal elaws have a subapieal tooth.

Cassis & Gross (1995) did not reeord any speeies of *Peritropis* from eontinental Australia. Gorezyea (1997a) deseribed the first Australian speeies, *Peritropis kotejai*, from a single speeimen from Kosciusko National Park in New South Wales. However, it has been known for some time that additional speeies exist in eolleetions. This work provides an overview of the genus in Australia with deseription of new speeies, and new reeords of other speeies in the Eastern Hemisphere. In this work we have not treated the Christmas Island speeies, *Peritropis listeri* Izzard, in detail, as we were unable to examine the holotype.

MATERIALS AND METHODS

Two hundred and seventy-six speeimens were examined in this study. Institutional aeronyms are AM, Australian Museum, Sydney; AMNH, American Museum of Natural History, New York; ANIC, Australian National Inseet Colleetion, CSIRO, Canberra; BPBM, Bernice P. Bishop Museum, Honolulu; DPIQ, Department of Primary Industries, Queensland, Brisbane; NTM, Northern Territory Museum, Darwin; QM, Queensland Museum, Brisbane; SAMA, South Australian Museum, Adelaide; USNM, United States National Museum, Washington D.C.; and, WAM, Western Australian Museum, Perth. Abbreviations used in material examined seetions are: Ck, Creek: DC, Doug Cook: GM, Geolf Monteith; GT, Geoff Thompson; Mt, Mount; Mtn, Mountain; NP, National Park; Pen., Peninsula; R., River; Ra., Range; Rd, Road; Tbld, Tableland.

Morphologieal teehniques and terminology follow those of Cassis (1995) and Cassis et al. (2003) and referenees therein. Deseription of the male genitalia is eomplex and positional statements refer to the resting position of the eomponents within the pygophore.

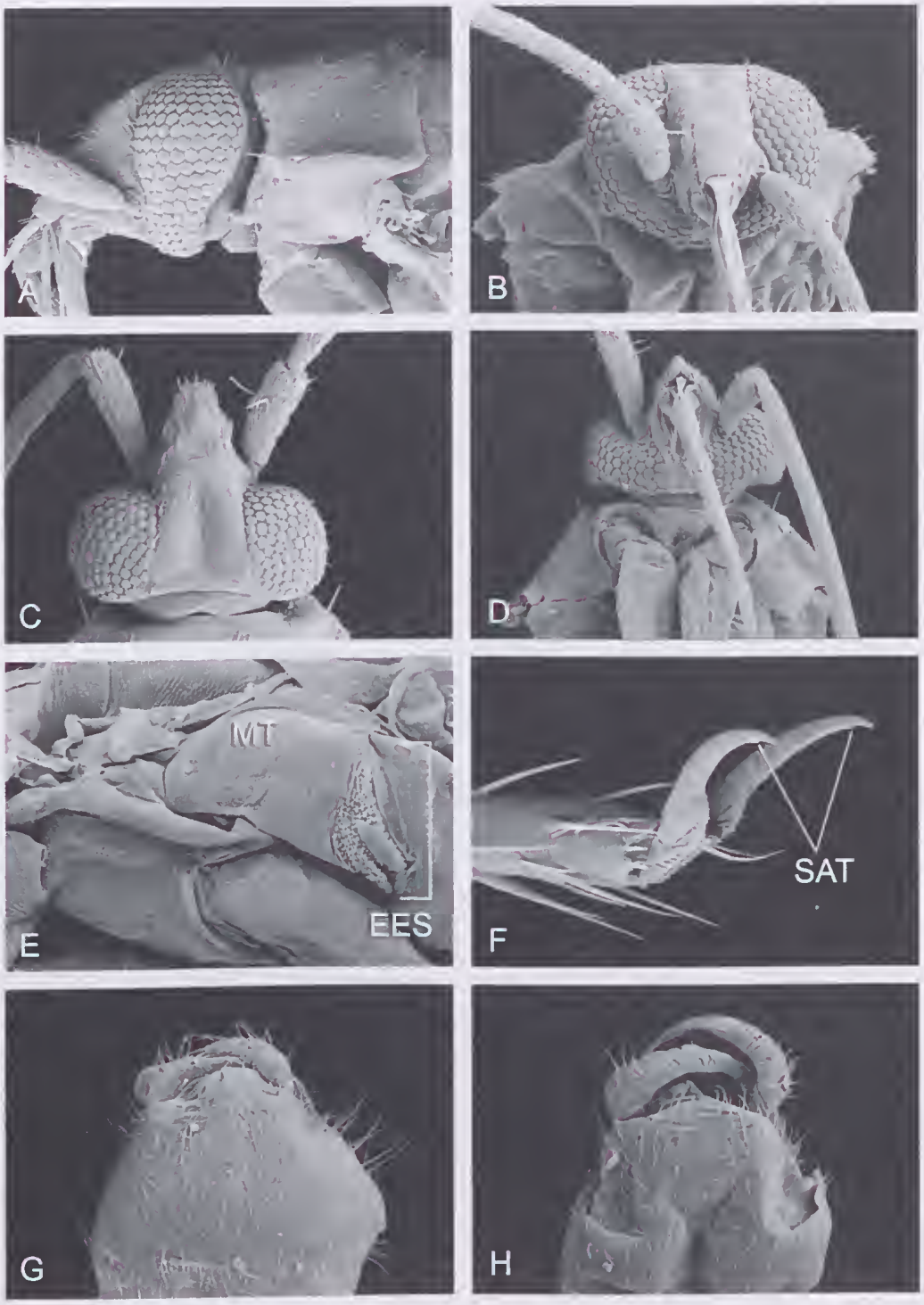


FIG. 1. A, *Peritropis roebucki* sp. nov. head lateral. B, *P. roebucki* sp. nov. head anterior. C, *P. roebucki* sp. nov. head dorsal. D, *P. roebucki* sp. nov.head ventral. E, *P. adusta* sp. nov. metathoraeie peritreme F, *P. adusta* sp. nov. tarsi G, *P. roebucki* sp. nov. pygophore ventral. H, *P. adusta* sp. nov. pygophore ventral. MT= metepisternum, EES= external efferent system. SAT= subapical teeth.

Species	PAL	AFR	ORI	AUS	NEA	NEO
adusta				x		
advena	x					
africana		x				
albaspecca				x		
annulicarnis				x		
aotcaroae				x		
armillarius		x				
basseti				x		
bicalor				x		
botswanica		x				
crassicornis		x				
electilis			x			
granulasa		x				
gressitti				x		
guamensis				x		
hasegawai	x					
husseyi					x	
insularis	x					
iriomatensis	x					
javanica			x			
kerzhneri		x				
kotejai			x	x		
lewisi			x			
linnavuorii		x				
listeri			x			
lugubris			x			
macrotricha		x				
maculicarnis		x				
maculisparsa		x				
magna		x				
malawiana		x				
minuta		x				
monikae				x		
nigripennis			x			
nilotica		x				
avocaledonicus				x		
abscurella		x				
phalaroptera				x		
pierrardi		x				
ponapensis				x		
poppiana			x			
postlei				x		
punctatus				x		
pusillus			x			
roebucki				x		
rostrata		x				
rugulosa		x				
rynskii		x				
saldaeformis					x	
schaeferi		x				
schmitzi		x				
selene		x				
setosicornis			x			
similis			x			
smreczynskii		x				
stysi		x				
suturella			x			
takahashii		x				
tanzanica		x				
tuberculatus						x
unicolor						x
vapensis				x		

All measurements are maximum lengths in millimetres. Abbreviations for morphometrie characters are: BL, body length; HW, head width across eyes; IOD, interocular distance; HL, head length; PL, pronotal length; PW, pronotal width at posterior margin; A11, length of second antennal segment; LL, labial length.

Scanning electron micrographs were prepared using techniques outlined in Bolte (1996) and Swearingen et al. (1997). Illustrations were drafted using a camera lucida and rendered using Adobe Illustrator software.

Locality information is given in the materials section of each species. For specimens lacking latitude and longitude information, coordinates were calculated using ESRI software (ArcInfo and ArcView) and are given in brackets.

TAXONOMY

Peritropis Uhler

Peritropis Uhler, 1891: 121; Bergroth, 1925: 159 (discussion); Carvalho, 1956: 9 (key to Micronesian spp.); Carvalho, 1957: 21 (catalogue); Schmitz, 1970: 504 (discussion and description); Schuh, 1995: 33 (catalogue); Gorczyca, 2000: 111 (key to African spp.).

TYPE SPECIES. *Peritropis saldaeformis* Uhler, 1891, by monotypy.

DIAGNOSIS. Macropterous (Figs 7, 11); body elongate-ovoid (Figs 7, 11) to ovoid; head porrect (Fig. 1A, C); eyes elongate, reniform, commonly reaching gula (Fig. 1A-C); antennae shorter than body; pronotum trapezoidal (Figs 7, 11), posterior margin excavate; labium slender (Fig. 1D); collar thin to absent (Fig. 1C); callosite region of pronotum moderately developed; external efferent system of metathoracic glands reduced (Fig. 1E) to posterior margin of metepisternum, peritreme short, tongue-like; metathoracic spiracle (Fig. 1E) exposed, without evaporative areas; pretarsal claws arcuate and slender with subapical tooth (Fig. 1F), setiform parempodia, sometimes asymmetrical; hemelytral embolium moderately explanate (Figs 7, 11); median flexion line relatively short, not reaching apex of clavai commissure (Figs 7, 11); cuneus

TABLE 1. Checklist of species of *Peritropis* and distribution by major zoogeographic region. PAL = Palearctic; AFR = Afrotropical; ORI = Oriental; AUS = Australian; NEA = Nearctic; NEO = Neotropical

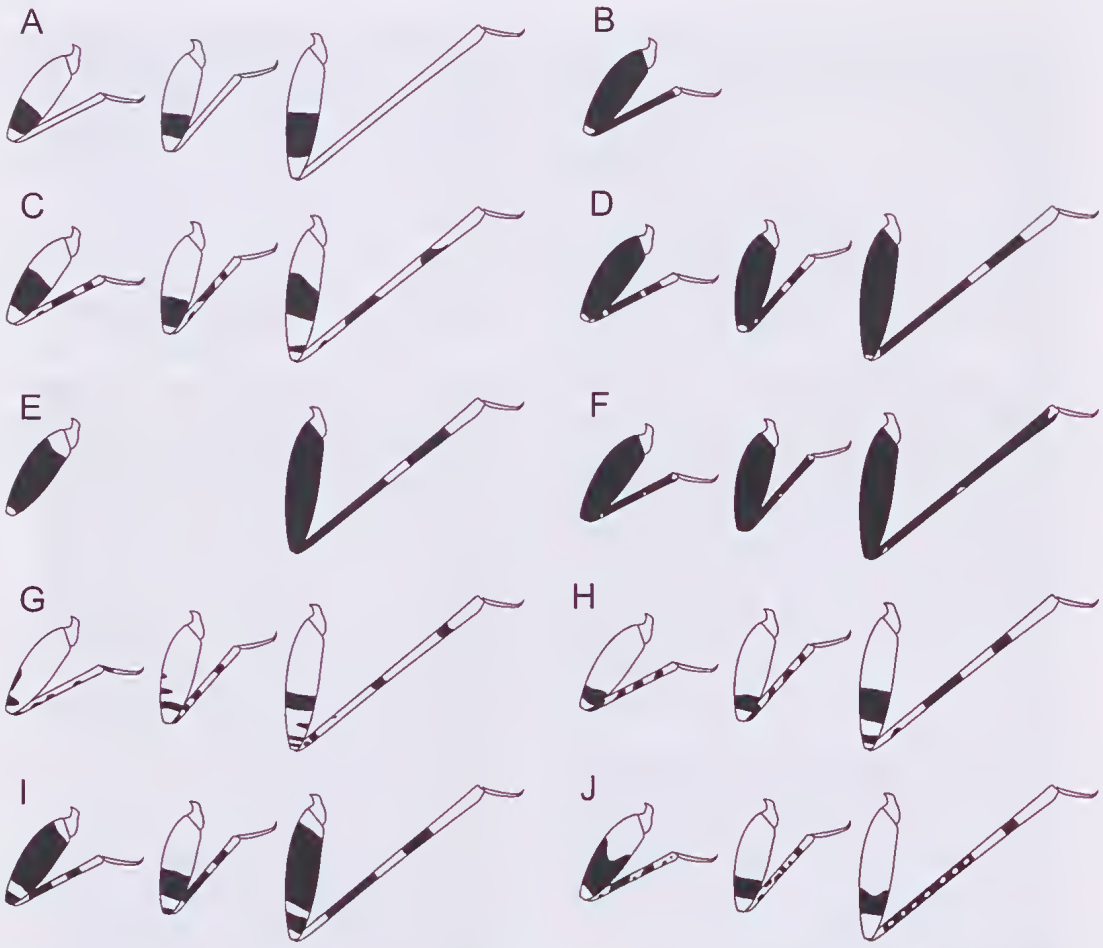


FIG. 2. Colour patterns on forefemora, mesofemora and metafemora of Australian species of *Peritropis*. A, *Peritropis adusta* sp. nov.; B, *P. albaspecca* sp. nov., mesofemora and metafemora absent in specimens examined. C, *P. aotearoae* sp. nov.; D, *P. basseti* sp. nov.; E, *P. kotejai* sp. nov. mesofemora absent in all specimens examined. F, *P. novocaledonicus* sp. nov.; G, *P. phalaroptera* sp. nov.; H, *Peritropis postlei*. I, *P. punctatus* sp. nov.; J, *P. roebucki* sp. nov.

slightly longer than wide, costal fracture present (Figs 7, 11); legs short, relatively slender; genital opening of male pygophore terminal in orientation (Figs 1G, H, 6A, B); parameres subequal in size (Fig. 1G, H) and sometimes roughly symmetrical (Fig. 6C, D); aedeagus with membranous sac-like endosoma, with 1 (Fig. 6E) or 2 endosomal spicules (Fig. 8E); sclerotised rings simple, basally tapered (Fig. 13A); posterior wall without interramal lobes (Fig. 13B).

DISTRIBUTION. There are 62 described species of *Peritropis*, with the genus now known from all major zoogeographic regions of the world (Table 1). The greatest diversity occurs in the Afrotropical (26 species), Oriental (12) and Australian (17) regions, indicating that the genus is predominately an Eastern Hemisphere group, and probably of Gondwanan origins. Only two species of *Peritropis* each are known from the Nearctic (Henry & Wheeler, 1988) and Neotropical regions (Schuh, 1995), although undescribed South American species are known in collections. Four species of *Peritropis* are known from the Palearctic (Kerzhner & Josifov, 1999) region. Considering the relative maturity of taxonomy in the Holarctic, it is unlikely that many new species of *Peritropis* will be found there. Aside from Yasunaga's (2000) description of three new species from Japan, there have been no new Northern Hemisphere species of *Peritropis*

FIG. 3. Distributions of *Peritropis adusta*, *P. albaspecca*, *P. aotearoae*, *P. basseti* and *P. kotejai* spp. nov.

described since Kerzhner's (1972) description of a new species from eastern Russia. Gorczyca (1997a-e, 1998, 1999, 2000) has described 24 of the known species, mostly from sub-Saharan Africa, and has made the most significant contribution in documenting the diversity of the genus. The *Peritropis* fauna of the Australian region is the least well known, and until this work, only one species was known from continental Australia (*P. kotejai*), with the other species known from Melanesia (Carvalho & Lorenzato, 1978) and Micronesia (Carvalho, 1956). It is likely that the actual diversity of the world fauna of *Peritropis* is still inadequately understood, as the habits of these cryptozoic mirids are poorly known. This is reflected by the fact that most specimens have been collected at light.

REMARKS. There are few mirid genera thought to be truly cosmopolitan, and even in highly speciose examples such as *Orthotylus* (Orthotylinae), there is considerable doubt as to whether these genera are monophyletic. In the basal subfamilies of the Miridae, particularly the Isometopinae and Cylapinae, there are stronger indications that some of the genera are truly cosmopolitan in distribution. For example, *Myiomma* (Isometopinae; Australian representatives undescribed), and *Fulvius* and *Peritropis* (Cylapinae) are upheld as monophyletic taxa across their cosmopolitan range.

The male genitalia are consistent with a number of other cylapine taxa, with the parameres roughly symmetrical, especially in comparison with mirids belonging to most other subfamilies, where the right paramere is often greatly reduced (e.g. Dicyphini) or different in shape (e.g. Orthotylini). The aedeagus is very simple, and is characterised by one or two endosomal sclerites.

The Australian species of *Peritropis* described here adhere to previous diagnoses of the genus (Schmitz, 1970; Gorczyca, 2000) and do not depart significantly from the character states found in the type species of the genus (*saldaeformis*). Our examination of numerous species of *Peritropis* from all regions of the world indicate that they are remarkably homogeneous in their morphology. Therefore, we redefine *Peritropis* to include the following character states: the metathoracic spiracle visible and external efferent system of the metathoracic glands reduced and oriented along the posterior margin of the metepisternum. The latter character state is akin to that found in *Fulvius* (Cassis, 1995).

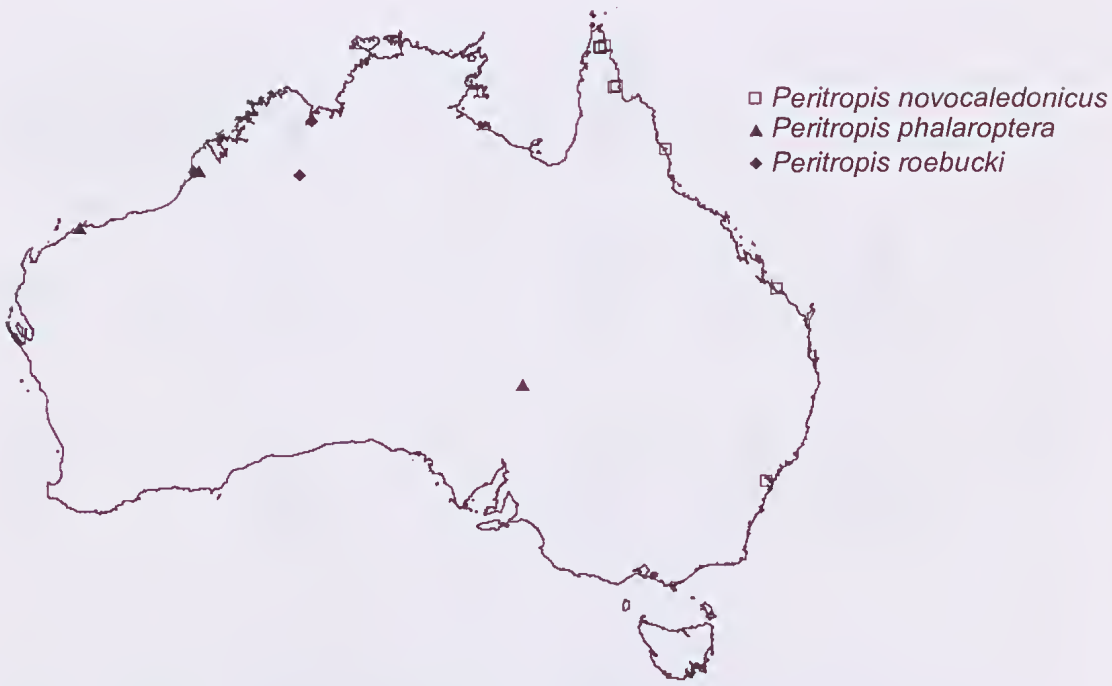


FIG. 4. Distributions of *Peritropis novocaledonicus*, *P. phalaroptera* and *P. roebucki* spp. nov.

TABLE 2. Checklist of Australian *Peritropis*

SPECIES	LOCATION
adusta sp. nov.	Western Australia
albaspecca sp. nov.	South Australia
aotearoae Gorczyca & Eyles, 1997	Queensland, Christmas Island, Papua New Guinea
basseti sp. nov.	Queensland
kotejai Gorczyca, 1997	New South Wales, Malaysia
listeri Izzard, 1936	Christmas Island
novocaledonicus Gorczyca, 1997	Queensland, New South Wales, New Caledonia
phalaroptera sp. nov.	Western Australia, South Australia
postlei sp. nov.	Western Australia
punctatus Carvalho & Lorenzato, 1978	Queensland, Western Australia, Australian Capital Territory, Papua New Guinea
roebucki sp. nov.	Western Australia

KEY TO AUSTRALIAN SPECIES OF *PERITROPIS*

(Note that *Peritropis listeri* is not included in this key)

1. Femora entirely dark brown to fuscous, commonly with a small stramineous marking distally (Fig. 2B, D, F) 2

   Femora stramineous, very commonly with two to three fuscous annulations of varying width (Fig. 2A, C, E, G-J) 4

2. Antennal segment II flattened . . . . . *basseti* sp. nov.

   Antennal segment II cylindrical. 3

3. Hemelytra generally entirely black to fuscous, occasionally with weak stramineous mottling; body elongate-ovoid; apex of scutellum occasionally with fuscous to mottled stramineous, longitudinal kings . . . . . *novocaledonicus* Gorczyca

   Hemelytra generally fuscous to brown with moderate stramineous mottling; body elongate and weakly ovoid; posterior termination of scutellum with large stramineous marking . . . . . *albaspecca* sp. nov.

4. Membrane clear and/or concolorous, stramineous mottling absent; apex of scutellum entirely fuscous; posterior margin of head with pair of triangular fuscous markings, often contiguous . . . . . *adusta* sp. nov.

   Membrane with stramineous mottling present; scutellum with stramineous markings at apex; posterior margin of head entirely stramineous, lacking triangular fuscous markings. 5

5. Antennal segment II stramineous with two broad, brown to fuscous annulations 6

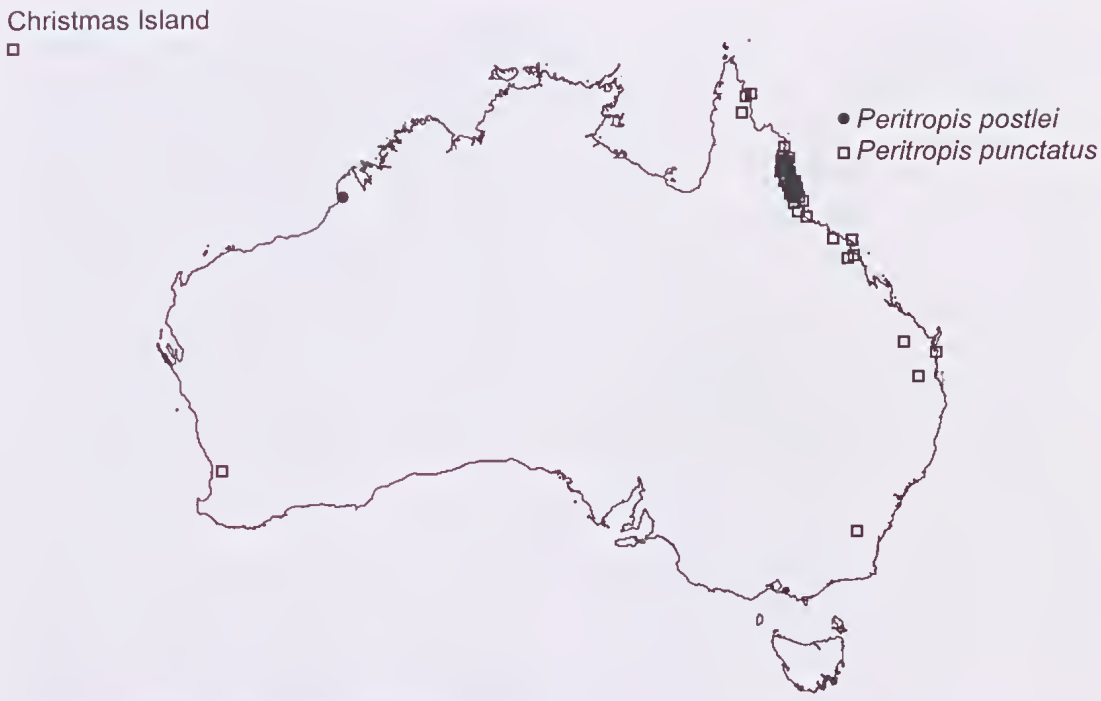


FIG. 5. Distributions: *Peritropis postlei* and *P. punctatus* spp. nov.

Antennal segment II fuscous with stramineous mottling or with small stramineous annulations 7

6. Body with dense covering of pale, adpressed, scale-like setae ..... *postlei* sp. nov.

Body with sparse to moderately dense covering of pale simple setae ..... *phalaroptera* sp. nov.

7. Forefemora with single, broad fuscous annulation (Fig. 2E) ..... *kotejai* Gorczyca & Eyles

Forefemora with fuscous annulations (Fig. 2C, I-J) 8

8. Metafemora with a single broad fuscous annulation on distal third (Fig. 2J) ..... *roebucki* sp. nov.

Metafemora with two fuscous annulations (Fig. 2C, I) 9

9. Metafemora with very thin fuscous annulation on distal quarter and broad fuscous annulation medially; apices of fore- and mesofemora stramineous (Fig. 2C) ..... *aotearoae* Gorczyca & Eyles

Metafemora with fuscous annulation on distal third and very broad fuscous annulation medially; base and apex of fore- and mesofemora fuscous (Fig. 2I) ..... *punctatus* Carvalho & Lorenzato

Peritropis adusta sp. nov.
(Figs 1E-F, 1H, 2A, 3, 6A-E, 7)

ETYMOLOGY. Latin *adustus*, referring to the fuscous scutellum and cuneus.

MATERIAL. HOLOTYPE: WESTERN AUSTRALIA: ♂, Roebuck Plains via Broome, (18.02°S 122.42°E), 10-13 December 1999, ex light trap, S Kniveton (AM). PARATYPES: WESTERN AUSTRALIA: Roebuck Plains via Broome, ex light trap as follows; 4♂♂, same data as holotype; 1♂, 30 Dec. 1997 – 2 Jan. 1998, C Johnston; 1♂, 22-25 Sept. 1998, C Brockway; 2♂♂, 30 Jan. 1998 – 4 Feb. 1998, C Brockway; 16♂♂, 5-8 Apr. 1998, A Postle; 2♂♂, 30 Nov. 1997, C Brockway; 1♂, 26-29 Jan. 1999, A Postle; 7♂♂, Wyndham (15.47°S 128.10°E), ex light trap as follows; 7♂♂, 10-13 Sept. 1999, N Wilson; 5♂♂, 8 Dec. 1999, T Vinnicombe; 5♂♂, 18-21 Dec. 1998, J De Long; Dip Yards, Broome, (17.97°S 122.23°E), ex light trap as follows; 2♂♂, 15-18 Dec. 1998, C Brockway; 1♂, 13 Oct. 1999, A Postle; 2♂♂, 16-19 Apr. 1999, A Postle; 3♂♂,13 Dec. 1999, S Kniveton (AM); 1♂, "12 mile" via Broome, (17.93°S 125.27°E), 10-13 Sept. 1999, ex light trap; 1♂, Karratha, (20.88°S 116.67°E), 25 May 1998, ex light trap, R Parr (all AM); 1♂, near Mount Gibson, (29.35°S 117.12°E) 11-12 Mar. 1982, ex light trap, TF Houston and B Hanich (434-3) (WAM 94/614); 1♂, Boorabbin Rock, (31.12°S 120.17°E), 20-21 Jan. 1982, ex light trap, B Hanich and TF Houston (433-3) (WAM 94/592); NORTHERN TERRITORY: 1♂, Lake Bennett area, 25km SE of Manton Dam, (22.83°S, 131.03°E), 29-30 Dec. 1979, MB Malipatil (NTM).

DIAGNOSIS. Second antennal segment incrassate (Fig. 7); head with stramineous markings on posterior margin of vertex (Fig. 7); cuneus fuscous, apex stramineous; forewing membrane stramineous (Fig. 7); scutellum fuscous; metafemora with broad fuscous

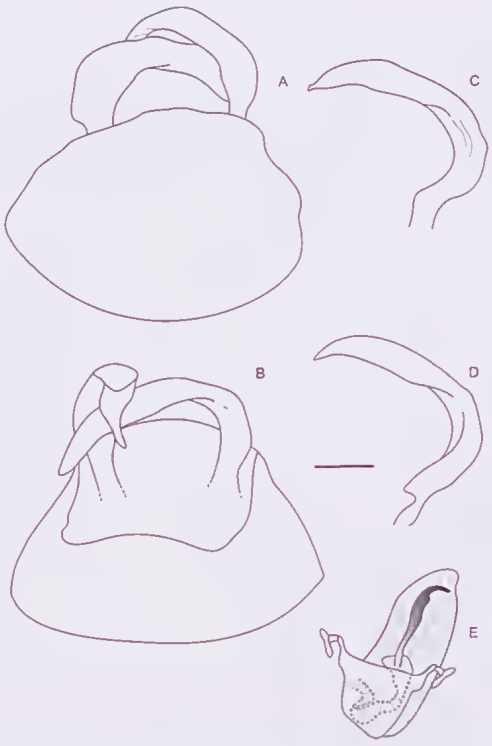


FIG. 6. *Peritropis adusta* sp. nov. male genitalia. A, pygophore ventral view. B, pygophore dorsal view. C, left paramere. D, right paramere. E, aedeagus. Scale bar 0.1mm.

annulation (Fig. 7); parameres sub-symmetrical (Fig. 6C, D); and, endosoma with single basal sclerite, apically arcuate (Fig. 6E). This species is similar to *P. postlei* in possessing a single basal sclerite (cf. Figs 6E, 10F), in contrast to most other species that possess two endosomal sclerites (e.g. *P. basseti*, Fig. 8D). *Peritropis adusta* is differentiated from *P. postlei* by the thickened second antennal segment, and the narrower body. In addition, the latter species possesses scale-like setae on the dorsum.

DESCRIPTION. *Colouration.* Head: stramineous with weak to strong red-fuscous mottling, circular red-fuscous markings adjoining eyes; posterior margin of vertex with pair of triangular red-fuscous markings, often contiguous. Antennae: AI stramineous with broad fuscous annulation medially, sometimes more extensive on apical half; AII-AIV stramineous to fuscous. Pronotum: stramineous with moderate to intense red to fuscous mottling, callosite region with strong fuscous to red mottling. Mesoscutum: red-fuscous with moderate stramineous mottling; anterior margin sometimes with 4 semicircular fuscous markings; lateral margins with red to stramineous longitudinal markings, intense stramineous mottling medially. Scutellum: red-fuscous to black with weak stramineous mottling; lateral margins black. Hemelytra: grey-brown to red-fuscous to black with intense stramineous mottling; embolium commonly black to fuscous, occasionally with red colouration; brown-fuscous to black markings extending from cuneus towards medial fracture; red-fuscous mottling anteriorly to costal fracture; cuneus predominately fuscous with stramineous extremities, membrane stramineous. Legs: stramineous, fore- and mesofemora with red to fuscous annulation on distal third, metafemora with very broad fuscous annulation medially (Fig. 2A).

Dorsal texture. Head, pronotum and hemelytra rugulose.

Vestiture. Hemelytra with moderately dense to sparse distribution of simple, erect, fine, pale setae.

Structure. Macropterous, elongate-ovoid. Head: posterior margin weakly convex; vertex weakly convex; antennal insertions slightly removed from eyes. Antennae: AI tapered basally; AIII-AIV short, slender. Eyes: greatly enlarged, reaching gula and contiguous with posterior margin of head. Pronotum: transverse, trapeziform; collar obsolete; callosite region moderately developed; medial foveae obsolete; anterior angles obtuse, lateral margins strongly explanate; posterior margin moderately concave, medially emarginate. Mesoscutum: prominent, strongly convex. Scutellum: flat, posterior third moderately declivent. Hemelytra: clavus moderately declivent; embolium moderately explanate; costal fracture weakly developed. Thoracic pleura: proepisternum anteriorly orientated; proepimeron deeply depressed medially; peritreme of metathoracic glands medially orientated; metathoracic spiracle exposed. Male genitalia (Fig. 6A-E): pygophore subconical (Fig. 6A); genital opening large (Fig. 6B), circular; left paramere (Fig. 6C) elongate, strongly curved with small, acute, apical termination; right paramere (Fig. 6D) elongate, strongly curved; aedeagus (Fig. 6E) with secondary gonopore shallow trough-shaped, ductus seminis moderately elongate and sclerotised, endosoma with single basal sclerite.

Measurements. 5♂♂ BL 2.35-2.73, HW 0.50-0.63, IOD 0.15 -0.27, HL 0.46-0.61, PL 0.29-0.36, PW 0.77-1.00, AII 0.70-0.96, LL 1.41-1.98.

REMARKS. *Peritropis adusta* is broadly distributed primarily in tropical Australia, from western NT to the Kimberley district of WA (Fig. 3). It has been collected primarily in semi-arid, monsoonal localities. This species is sympatric with *P. phalaroptera*, *P. postlei* and *P. roebucki*, at Roebuck Plains, near Broome.

Peritropis albaspecca sp. nov.
(Figs 2B, 3)

ETYMOLOGY. Taken from the Latin *albus*, meaning white, and *specca*, referring to the stramineous mottling covering the dorsal surface.

MATERIAL. HOLOTYPE: SOUTH AUSTRALIA: 1♀, Kangaroo Island, (35.83°S 138.05°E), (SAMA). PARATYPE: 1♂, same data as holotype (SAMA).

DIAGNOSIS. Dorsum with uniform stramineous mottling; AII fuscous with medial stramineous annulation; scutellum fuscous with posterior third stramineous; forewing membrane grey with stramineous mottling; and, forefemora mostly fuscous with apex stramineous (Fig. 2B). *Peritropis albaspecca* is similar to *P. novocaledonicus*. It is best distinguished from it by the less ovoid body, more mottling on the hemelytra, and the larger stramineous marking on the apex of the scutellum.

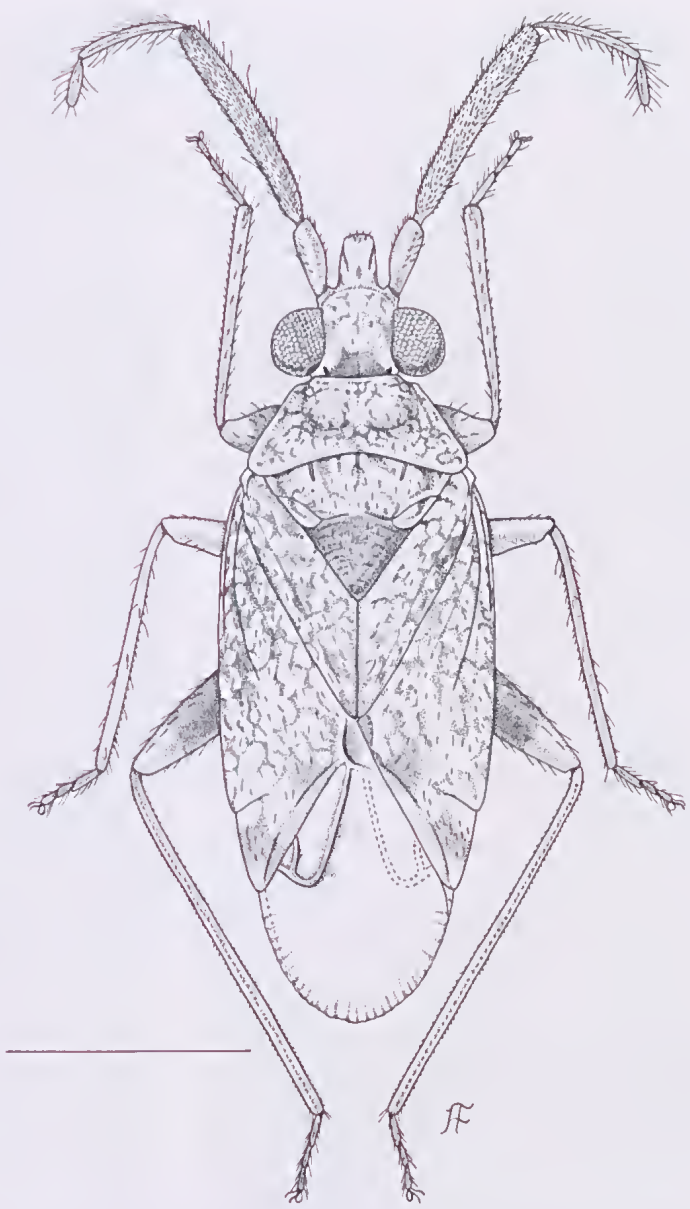


FIG. 7. Dorsal habitus of *Peritropis adusta* sp. nov., scale bar 0.8 mm.

DESCRIPTION. *Colouration.* Head: dark brown to fuscous with moderate stramineous mottling. Antennae: mostly fuscous; AI stramineous basally, with circular stramineous marking medially; AII with stramineous annulation medially. Pronotum: red-fuscous with moderate stramineous mottling; posterior margin with two semicircular fuscous markings medially. Mesoscutum: fuscous. Scutellum: fuscous with weak stramineous mottling, basal third stramineous. Hemelytra: stramineous to red-fuscous laterally, with moderate stramineous mottling; membrane grey-brown with moderate stramineous mottling. Legs: fuscous, apex of forefemur and foretibia stramineous (Fig. 2B), mid and hind legs missing.

Dorsal texture. Head, pronotum and hemelytra rugulose.

Vestiture. Hemelytra with moderately dense distribution of simple, semi-erect, fine, pale setae.

Structure. Macropterous, elongate-ovoid. Head: posterior margin rectilinear, vertex moderately excavate, antennal insertions contiguous with eyes. Antennae: AI tapered basally, AIII-AIV shortened and slender. Eyes: reaching gula and contiguous with posterior margin of head. Pronotum: transverse, trapeziform; collar obsolete; callosite region moderately developed, medial foveae obsolete; anterior angles obtuse; lateral and posterior margins strongly explanate; posterior margin sinuate. Mesoscutum: prominent, strongly convex. Scutellum: flat, posterior third moderately declivent. Hemelytra: clavus moderately declivent with narrow ridge medially; embolium moderately explanate; costal fracture weakly developed. Thoracic pleura: proepisternum anteriorly orientated; proepimeron deeply depressed medially; peritreme of meta-thoracic glands weakly fusiform, medially oriented; metathoracic spiracle exposed. Male and female genitalia not examined.

Measurements. 1♂ BL 2.50, HW 0.54, IOD 0.27, HL 0.42, PL 0.33, PW 0.96, AII 0.63, LL 1.17; 1♀ BL 2.67, HW 0.55, IOD 0.30, HL 0.45, PL 0.38, PW 0.97, AII 0.68, LL 1.24.

REMARKS. *Peritropis albaspecca* is known only from the type locality on Kangaroo Island in SA (Fig. 3). Kangaroo Island is not known to be a significant centre of endemism and it is unlikely that *P. albaspecca* is restricted to the island.

Peritropis aotearoae Gorczyca & Eyles, 1997
(Figs 2C, 3)

Peritropis aotearoae Gorczyca & Eyles 1997: 226.

DIAGNOSIS. Antennae fuscous with stramineous mottling; scutellum subdistally with stramineous marking; femora mostly stramineous with subdistal fuscous annulation (Fig. 2C). *Peritropis aotearoae* is distinguished from *P. punctatus* by the colouration of the femora. The metafemur of *P. punctatus* has a very broad fuscous annulation medially and a thin fuscous annulation on the distal quarter, with the apex stramineous (cf Figs 2C & 21). In comparison, the metafemur of *P. aotearoae* has a broad fuscous annulation submedially and a narrow subapical fuscous annulation.

MATERIAL. QUEENSLAND: 1♂, Cairns district, (16°55'S 145°46'E), AM Lea (SAMA); 2♀♀, Kuranda, (16°49'S 145°36'E), FP Dodd (SAMA); CHRISTMAS ISLAND: 2♀♀, Central area workshop, 10.29°S 105.37°E, 25 Apr 1989, JC Cardale, on lichen covered bark mainly at light (ANIC); PAPUA NEW GUINEA: 1♀, Bisiatabu, Port Moresby, WN Loek (SAMA).

REMARKS. *Peritropis aotearoae* was previously known only from New Zealand. The specimens from north Queensland, Christmas Island and Papua New Guinea (Fig. 3) significantly extend the range of this species. This species is known from temperate forests in New Zealand to tropical rainforests in north Queensland.

Peritropis basseti sp. nov.
(Figs 2D, 3, 8A-D)

ETYMOLOGY. For Dr Yves Basset who collected the type material.

MATERIAL. HOLOTYPE: 1♂, Mount Glorious, 27°19'S 145°45'E, 700m, January 1988, Y Basset *Argyrodendron actinophyllum* (QM). PARATYPES: QUEENSLAND: Mount Glorious, 27°19'S 145°45'E, 700m, Y Basset *Argyrodendron actinophyllum* as follows; 1♂, same data as holotype; 1 sex undetermined (damaged), Jan 1987; 2♀♀, Jan-Feb 1987; 1♂, Jan-Feb 1988; 1♂1♀, Feb 1986, (AM); 1♂, Feb 1988; 1♀, Feb-Mar 1986; 1♂1♀1 sex undetermined (damaged), Mar 1987; 2♂♂, Mar-Apr 1986 (AM); 1♂, Apr 1986; 3♂♂, Apr 1987; 1♂, Nov-Dec 1986; 1♀, Nov 1987; 2♀♀, Dec 1986; 1♂, Dec 1987 (all QM unless indicated).

DIAGNOSIS. Distinguished by the following combination of characters: antennal segment II laterally flattened; scutellum with stramineous marking basally darkened; hemelytra with minor stramineous mottling; right paramere larger than left (cf. Figs 8B & C), with shaft of former flanged; and, endosoma with two selerites, distal selerite strongly arcuate (Fig. 8D). *Peritropis basseti* closely resembles *P. punctatus* with the latter is distinguished by the flattened antennal segment AII, completely fuscous tibiae, and generally darker *Colouration.*

DESCRIPTION. *Colouration.* Head: brown to fuscous, commonly with weak stramineous mottling. Antennae: fuscous, occasionally with weak stramineous mottling; AII with a single stramineous spot medially. Pronotum: fuscous to brown with weak mottling. Mesoscutum: fuscous with weak stramineous mottling. Scutellum: fuscous with weak stramineous mottling, stramineous marking basally. Hemelytra: fuscous to brown with weak to moderate stramineous mottling; cuneus fuscous with basal third stramineous; costal fracture stramineous; posterior margin of hemelytra with fuscous marking, sometimes indistinct red-brown markings present; membrane grey with stramineous mottling. Legs: fuscous; tibiae commonly with two to three stramineous annulations (Fig. 2D).

Dorsal texture. Head, pronotum and hemelytra rugulose.

Vestiture. Hemelytra with moderate distribution of adpressed, pale, scale-like setae.

Structure. Macropterous, elongate-ovoid. Head: posterior margin weakly convex; vertex weakly concave; antennal insertions contiguous with eyes. Antennae: AI tapered basally; AII flattened laterally; AIII-AIV shortened and abruptly slender. Eyes: reaching bucculae and contiguous with posterior margin of head. Pronotum: transverse, trapeziform; collar obsolete; callosite region moderately to strongly developed; medial foveae obsolete; anterior angles obtuse, lateral margins strongly explanate; posterior margin moderately concave, medially emarginate. Mesoscutum: prominent, strongly convex. Scutellum: flat, posterior third moderately declivent. Hemelytra: clavus moderately declivent; embolium moderately explanate; costal fracture weakly developed. Thoracic pleura: proepisternum anteriorly orientated; proepimeron deeply depressed medially; peritreme of metathoracic glands medially orientated; spiracle exposed. Male genitalia: (Fig. 8A-D), pygophore subconical (Fig. 8A); genital opening large (Fig. 8A), circular. Left paramere: (Fig. 8B), moderately elongate, basal lobe weakly to moderately developed, apical third with small ridge, apical termination moderately rounded. Right paramere: (Fig. 8C), elongate and strongly curved apical termination acute. Aedeagus: (Fig. 8D), secondary gonopore trough shaped, ductus seminis moderately elongate and sclerotised, two endosomal sclerites present, distal one strongly arcuate.

Measurements. 5♂♂ BL 2.52-2.94, HW 0.62-0.66, IOD 0.29-0.30, HL 0.47-0.53, PL 0.42-0.48, PW 1.01-1.13, AII 0.88-0.94, LL 1.88; 5♀♀ BL 3.20-3.76, HW 0.60-0.72, IOD 0.29-0.39, HL 0.55-0.60, PL 0.52-0.57, PW 1.23-1.31, AII 0.93-1.02, LL 1.90.

REMARKS. *Peritropis basseti* (Fig. 3) is known only from the type locality and occurs within the range of the closely-related *P. punctatus*.

Peritropis kotejai Gorczyca, 1997
(Figs 2E, 3)

Peritropis kotejai Gorczyca, 1997a: 555
Peritropis listeri (Izzard, 1936)
Cylapofulvius listeri Izzard, 1936: 587; Carvalho, 1957: 13 (catalogue); Carvalho, 1981: 2 (diagnosis; genus position); Schuh, 1995: 22 (catalogue); Cassis & Gross, 1995: 147 (catalogue)

FIG. 8. *Peritropis basseti* sp. nov. male genitalia; A, pygophore dorsal view; B, left paramere; C, right paramere; D, aedeagus with theca; scale bar 0.1mm.

Peritropis listeri Gorczyca, 1997c: 181 (new combination; diagnosis)

MATERIAL. NEW SOUTH WALES: 1♀, Sydney, (33°52'S 151°12'E), Lea (SAMA); MALAYSIA: 1♀, Gap (Fraser's Hill), Malay Peninsula, AM Lea and wife (SAMA).

DIAGNOSIS. Mesoscutum fuscous with longitudinal stramineous band laterally; scutellum with moderately large stramineous marking basally; hemelytra red-brown with stramineous mottling, large brown fuscous markin gon apical third contiguous, or nearly so, with clavus; and femora mostly fuscous, with extremities narrowly stramineous (Fig. 2E). *Peritropis kotejai* is distinguished from *P. roebucki*, *P. aotearoae* and *P. punctatus* by its almost entirely fuscous forefemora that have a very wide fuscous annulation (cf. Fig. 2E & 2C, 2I-J). *Peritropis kotejai* is distinguished from *P. basseti* by the basal stramineous marking on the forefemora in the former (cf. Fig. 2E & 2D).

REMARKS. The material examined significantly extends the range of this species into the tropics (Fig. 3). It was originally described from Kosciusko

National Park, NSW (Gorczyca, 1997a). We tentatively assign the Malaysian specimen to this species on the basis of the colour patterns of its femora.

We have not had access to the type material of *P. listeri* and have not been able to confirm its identity. Izzard (1936) first described the species from a male from Christmas Island. He gave a detailed description of its colour and structure of the species but did not describe its genitalia. Carvalho (1981) first questioned the generic placement of the species, and gave a brief morphological diagnosis. Gorczyca (1997c) placed it in *Peritropis*, making reference to the porrect head, oval and smooth body, and the developed cuneal fracture. We have identified additional specimens of *Peritropis* from Christmas Island as *P. aeotearoae*, originally considered endemic to New Zealand (Gorczyca & Eyles 1997). We conclude that these specimens are not conspecific with *P. listeri*, on the basis that Izzard's (1936) description indicated that the legs are pale yellow. In contrast, the specimens we examined have banded legs (Fig. 2C).

Peritropis novocaledonicus Gorczyca, 1997
(Figs 2F, 4)

Peritropis novocaledonicus Gorczyca, 1997b: 559.

MATERIAL. QUEENSLAND: 1♀, Mellwraith Range, NE of Coen, Cape York Pen., (13°45'S 143°20'E), 29 June 1976, JF Donaldson (DPIQ); 1♀, Coen Area, Cape York Pen., (13°48'S 143°12'E), 6-12 May 1975, KJ Houston (DPIQ); 1♀, Cairns district, FP Dodd (AM); 1♀, Bertie Ck, Cape York Pen., 11°50'S 142°30'E, 13 Mar. 1992, G Cassis at light (AM); 2♀♀, Junction of Bamaga and Captain Billy Landing Rds, 11°41'S 142°42'E, 23 Mar 1992, G Cassis at light (AM); 1♂ (dissected), Heathlands, 11°45'S 142°25'E, 15-26 Jan 1992, I Naumann and T Weir at light (ANIC); 1♂, Canoe Point E.P., 23°56'S 151°21'E, 5m, 20 Mar 2000, GM pyrethrum trees, vine scrub (QM); NEW SOUTH WALES: 1♀, Scheyville, (33°37'S 150°53'E), Jan 1988, HF Recher, from narrow-leaved ironbark *E. crebra* (AM).

DIAGNOSIS. Body generally oval and almost uniformly black to brown, sometimes with weak stramineous mottling; scutellum with pair of brown to stramineous longitudinal markings, nearly contiguous with apex; and uniformly black femora and mostly black tibiae (Fig. 2F). *Peritropis novocaledonicus* is distinguished from *P. albaspecca* by the more ovoid body shape, the generally darker hemelytra with mottling weak to absent, and the less distinct fuscous to stramineous markings on the posterior region of the scutellum.

REMARKS. *Peritropis novocaledonicus* is here recorded from the east coast of Australia (Fig. 4) for the first time. The distribution of the species from tropical and monsoonal north Queensland to the temperate region of Sydney supports the notion that numerous species of *Peritropis* have broad climatic ranges.

Peritropis phalaroptera sp. nov.
(Figs 2G, 4, 9A-E)

ETYMOLOGY. Greek, *phalaroptera*, referring to the white spots present on the forewing membrane.

MATERIAL. HOLOTYPE: WESTERN AUSTRALIA: 1♂, Dip Yards, Broome, (17.97°S 122.23°E), 15-18 December 1998, ex light trap, C Brockway (AM). PARATYPES: WESTERN AUSTRALIA: 2♂♂, Karratha, (20.88°S 116.67°E), 19-22 Jan. 1999, R Parr (AM); SOUTH AUSTRALIA: 1♂, Minnie Downs, NE corner of South Australia, L Reese (SAMA); 1♀, Cannuwaukaninna Dune, 16km W of Etadunna Homestead, (28.79°S 138.55°E), 6 Mar. 1972, EG Matthews (SAMA).

DIAGNOSIS. Antennal segment AII with distinctive fuscous annulations medially and at apices; pronotum stramineous medially; forewing membrane grey with stramineous mottling; and parameres asymmetrical, with left smaller than right (Fig. 9C, D). *Peritropis phalaroptera* is distinguished from *P. postlei* in having sparse, pale, scale-like setae on the body. The parameres of the two species are also differently shaped (cf. Figs 9C, D & 10C, D).

DESCRIPTION. *Colouration*. Head: stramineous with weak red mottling to brown. Antennae: AI brown with stramineous mottling, basal half stramineous, occasionally entirely stramineous; AII stramineous with two fuscous annulations, apex fuscous; AIII-AIV stramineous. Pronotum: fuscous with stramineous mottling, medially with trapeziform stramineous marking. Mesoscutum: fuscous to brown. Scutellum: brown with weak to moderate stramineous mottling, posterior third with stramineous annulation. Hemelytra: stramineous, weak red and brown mottling to strong brown mottling; fuscous circular markings near cuneus; membrane grey with strong stramineous mottling. Legs: stramineous; femora with red to fuscous annulations on the distal third; tibiae with three red to fuscous annulations and occasionally mottling (Fig. 2G).

Dorsal texture. Head, pronotum and hemelytra rugulose.

Vestiture. Head and body with moderately dense distribution of simple, fine, pale, erect setae.

Structure. Macropterous, elongate. Head: posterior margin weakly concave; vertex medially sulcate; antennal insertions contiguous with eyes. Antennae: AI tapered basally; AIII-AIV shortened and slender. Eyes: reaching gula and contiguous with posterior margin of head. Pronotum: transverse, trapeziform; collar obsolete; callosite region moderately developed, medial foveae obsolete; anterior angles obtuse, lateral margins strongly explanate, posterior margin sinuate. Mesoscutum: prominent, strongly convex. Scutellum: weakly declivent, posterior termination moderately declivent. Hemelytra: clavus moderately tectiform; embolium moderately explanate; costal fracture weakly developed. Thoracic pleura: procpisternum anteriorly orientated; proepimeron deeply depressed medially; peritreme of metathoracic glands medially orientated, weakly fusiform; spiracle exposed. Male genitalia (Figs 9A-E): pygophore subconical (Fig. 9A); genital opening large (Fig. 9B, E), circular; left paramere (Fig. 9C) short; apical third thin and strongly curved; apical termination broken in specimen examined; right paramere (Fig. 9D) elongate and moderately curved; apical termination acute; aedeagus not examined.

Measurements. 3♂♂ BL 1.82-2.40, HW 0.51-0.68, IOD 0.16-0.25, HL 0.35-0.54, PL 0.26-0.36, PW 0.67-0.96, AII 0.59-0.88, LL 1.08-1.47; 1♀ BL 2.85, HW 0.75, IOD 0.40, HL 0.46, PL 0.44, PW 1.16, AII 1.02. LL not measured.

REMARKS. *Peritropis phalaroptera* has been collected mostly in arid areas. The specimens from northern WA are very widely separated from that from north-eastern SA populations (Fig. 4).

Peritropis postlei sp. nov.
(Figs 2H, 5, 10A-F)

ETYMOLOGY. For Dr Tony Postle.

MATERIAL. HOLOTYPE: WESTERN AUSTRALIA: 1♂, Roebuck Plains via Broome, (18.02°S 122.42°E), 22-25 September 1998, ex light trap, C Broekway (AM). PARATYPES: 1♂ 1♀, same data as holotype (AM).

DIAGNOSIS. Dense adpressed scale-like setae on body; membrane grey with stramineous mottling; fuscous annulations on antennae and legs (Fig. 2H); sub-symmetrical parameres (Fig. 9C, D); and, a single endosomal basal sclerite. *Peritropis postlei* is distinguished from *P. roebucki* and *P. phalaroptera* in having dense, adpressed, pale, scale-like setae on the entire habitus. The genitalia of *P. postlei* closely resemble those of *P. adusta*. They both have roughly symmetrical parameres (cf. Figs 6C, D & 9C, D) and an aedeagus with a single basal sclerite, although paramere shape varies between the species (cf. Figs 6E & 9F).

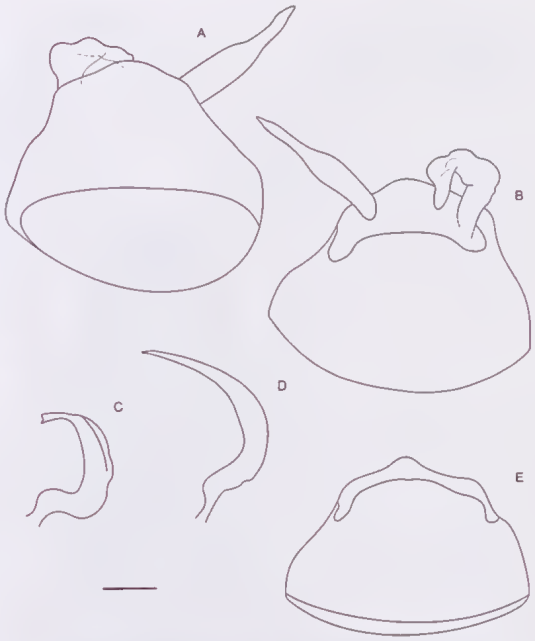


FIG. 9. *Peritropis phalaroptera* sp. nov. male genitalia. A, pygophore ventral view; B, pygophore dorsal view; C, left paramere; D, right paramere; E, genital opening dorsal view; scale bar 0.1mm.

DESCRIPTION. *Colouration.* Head: stramineous with occasional red mottling, sometimes with 1 or 2 fuscous circular markings contiguous with eyes. Antennae: AI brown-fuscous, basal third stramineous; AII stramineous with two wide fuscous annulations medially, apex fuscous; AIII-AIV dark stramineous. Pronotum: stramineous with weak red-orange mottling, anterior lateral margins fuscous. Mesoscutum: brown-fuscous, posterior lateral margins with weak stramineous to red mottling. Scutellum: brown with weak red mottling, posterior third stramineous or with two almost contiguous circular stramineous markings. Hemelytra: stramineous to brown with weak red mottling, fuscous marking extending from

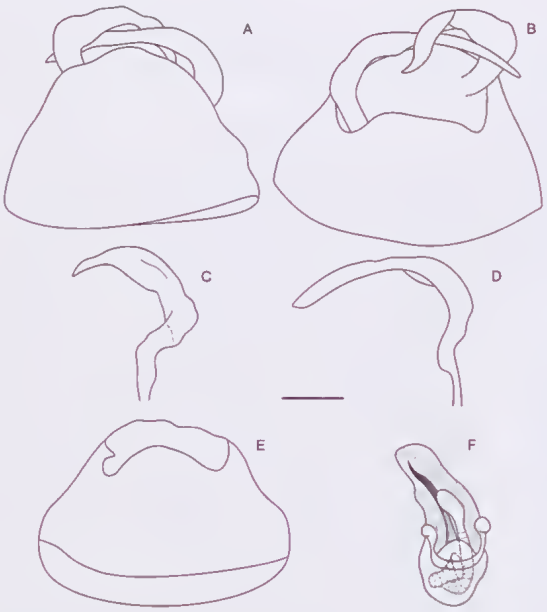


FIG. 10. *Peritropis postlei* sp. nov. male genitalia. A, pygophore ventral view; B, pygophore dorsal view; C, left paramere; D, right paramere; E, genital opening dorsal view; F, aedeagus with theca; scale bar 0.1mm.

posterior half of claval commissure to cuneus; embolium with indistinct red to fuscous markings; membrane grey-brown with stramineous mottling. Legs: stramineous, fore- and mesofemora with narrow red to fuscous annulations on distal third; metafemora with a broad red-fuscous annulation on distal half and a red-fuscous annulation near the distal termination; tibiae with three fuscous annulations and occasional mottling (Fig. 2H).

Dorsal Texture. Head, pronotum and hemelytra rugulose.

Vestiture. Head and body with dense distribution of adpressed, pale, flattened, scale-like setae.

Structure. Macropterous, elongate. Head: posterior margin rectilinear, vertex moderately sulcate medially; antennal insertions contiguous with eyes. Antennae: AI tapered basally; AIII-AIV shortened and slender. Eyes: reaching gula and contiguous with posterior margin of head. Pronotum: transverse, trapeziform; collar obsolete; callosite region moderately developed; medial foveae obsolete; anterior angles obtuse, lateral margins strongly explanate; posterior margin sinuate. Mesoscutum: prominent, strongly convex. *Scutellum: flat.* Hemelytra: clavus moderately declivent with narrow ridge medially; embolium moderately explanate; costal fracture weakly developed. Thoracic pleura: proepisternum anteriorly orientated; proepimeron deeply depressed medially; peritreme of metathoracic glands small, tumid, medially orientated; spiracle exposed. Male genitalia (Figs 10A-F): pygophore subconical (Fig. 10A); genital opening large (Fig. 10B, E), circular; left paramere (Fig. 10C) elongate, curved with small, acute, apical termination; right paramere (Fig. 10D) extremely elongate and strongly curved; aedeagus (Fig. 10F) with secondary gonopore shallow, trough-like, ductus seminis moderately elongate and sclerotised, endosoma with a single basal sclerite.

Measurements. 2♂♂ BL 1.40-1.80, HW 0.43, IOD 0.19-0.20, HL 0.28-0.35, PL 0.22-0.24, PW 0.68-0.73, AII 0.50-0.53, LL 0.92-1.23; 1♀ BL 1.76, HW 0.46, IOD 0.22, HL 0.37, PL 0.23, PW 0.72, AII 0.57, LL 0.97.

REMARKS. *Peritropis postlei* is known only from the type locality, Roebuck Plains near Broome (Fig. 5) and is sympatric with *P. adusta* and *P. roebucki*. Like the two latter species, we expect the actual distribution of *P. postlei* to include much of monsoonal northern Australia.

Peritropis punctatus Carvalho & Lorenzato, 1978 (Figs 21, 5)

Peritropis punctatus Carvalho & Lorenzato, 1978: 145; Schuh, 1995: 34 (catalogue)

MATERIAL. 73♂♂, 85♀♀ 2 sex undetermined (damaged), (AM, QM unless indicated) from the following localities QUEENSLAND: Mt Lewis via Mossman, 1500-3000', December (19)57, J Darlington (AMNH); Kuranda, (16°49'S 145°36'E), 200m, 12/iii/1956, JL Gressitt (BPBM); 1km SE Mt Cook, 15.30°S 145.16°E, 13/x/1980, T Weir (ANIC); Bellenden Ker Ra., Cableway Base Stn, (17.16°S 145.54°E), 100m, 17/x – 9/xi/981, Earthwatch/QM; Bellenden Ker Ra., 1km S Cable Tower 6, (17.16°S 145.53°E), 500m, 17 Oct. – 9 Nov. 1981, Earthwatch/QM; Mt Fort Williams via Kalpowar, 18/i/990, GM; Tower near The Crater NP, 17°27'S 145°29'E, 1230m, 25/xi/1994, GM; Vine Ck Rd, 17°27'S 145°32'E, 1100m, 24/xi/1994, GM; Graham Ra., 17°17'S 145°58'E, 550m, 1/xi/1995, GM; Upper Mulgrave Rd, Kearneys Falls, (17°14'S 145°47'E), 100m, 10/xii/1988, GM & GT; Lamb Ra., 19km SE Mareeba, (17°07'S 145°38'E), 1200m, 3/xii/1988, GM & GT; Carbine Tbld, plane crash site, (16°27'S 145°11'E), 1330m, 28/xi/1990, GM & Janetzki; Mt Formartine South, 10km N Kuranda, 700m, 23/xi/1990, GM & GT; Davies Ck Rd, 20km SE Mareeba, 750m, 17/

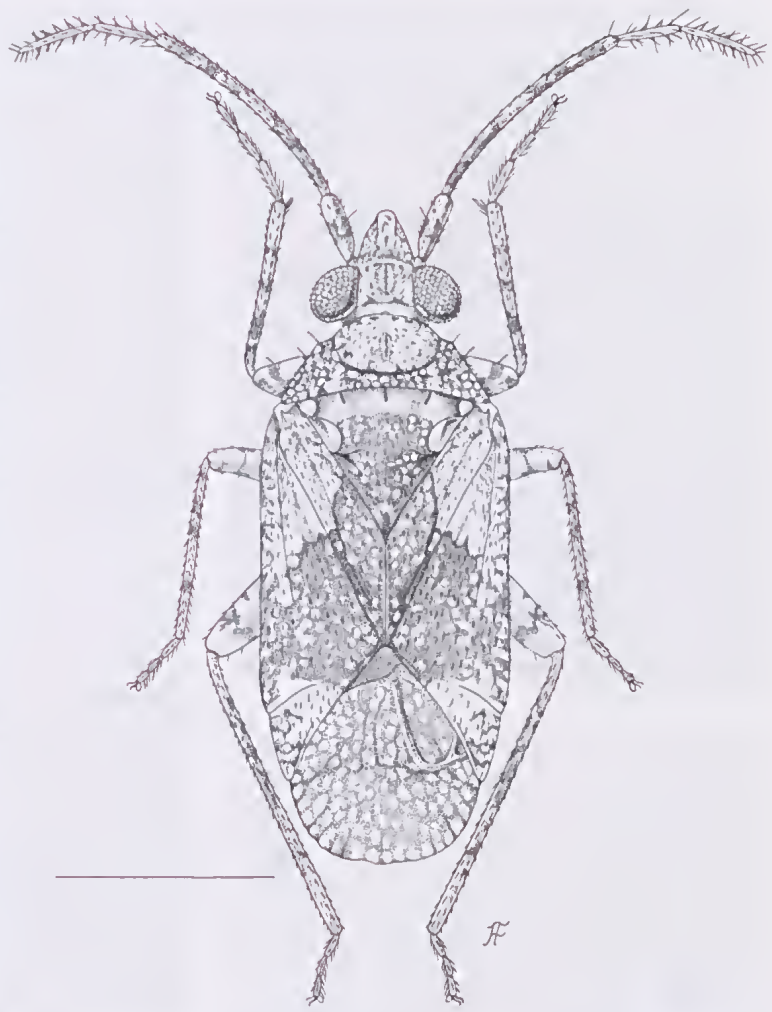


FIG. 11. Dorsal habitus of *Peritropis roebucki* sp. nov.; scale bar 0.8 mm.

xii/1989, GM & GT; Bell Peak North, Malbon Thompson Ra., (17°05'S 145°53'E), 600m, 22/xi/1990, GM & GT; Upper Cattle Ck, Eungella, 21°02'S 148°36'E, 900m, 17/xi/1992, GM, GT & Janetzki; Mt Mcartney, 20°50'S 148°34'E, 900m, 19/xi/1992, GM, GT & Janetzki; Charmillin Ck, 17°42'S 145°31'E, 940m, 1/xii/1997, GM; West Claudie R, Iron Ra., (12°44'S 143°17'E), 3-10/xii/1985, GM & DC; Baldy Mtn Rd, 7km SW Atherton, (17°16'S 145°28'E), 1150m, 9/xii/1988, GM & GT; Mount Bartle Frere, west side, (17°22'S 145°49'E), 1050m, 8/xii/1990, GM, GT and Sheridan; Mossman Bluff track, 9km W Mossman, (16°26'S 145°16'E), 1000m, 22/xii/1989, GM, ANZSES pyrethrum site 7; Windsor Tbld, 35km NNW Mount Carbine, (16°13'S 145°02'E), 1050m, 25-26/iv/1982, GM, D Yeates & DC; Windsor Tbld, 5.7km past barraeks, 16°14'S 145°00'E, 1300m, 24/xi/1997, GM; Wallaman Falls Rd, 1km W junetion, 18°39'S 145°52'E, 650m, 12/ii/1996, GM; Mt Dryander, 20°15'S 148°33'E, 700m, 21/xi/1992, GM, GT & Janetzki; Cardwell Ra., Mt McAlister area, (17°34'S 145°33'E), 1000m, 19/xii/1986, GM, GT & Hamlet; Sluice Ck, 9km WSW Millaa Millaa, (17°31'S 145°31'E), 1150m, 5/xii/1988, GM & GT; Mt Boolbun South, 15°57'S 145°08'E, 850m, 5/xi/1995, GM; McDowall Ra., 17km N Daintree, (16°03'S 145°15'E), 520m, 27/xi/1985, GM & DC; Tully R. erossing, 10km S Koombooloomba Dam, (18°02'S 146°03'E), 750m, 4/i/1990, GM; 2km SE Mt Spurgeon via Mount Carbine, (16°28'S 145°12'E), 1100m, 20/xii/1988, GM & GT; Hann Tbld, north end, 16°49'S 145°11'E, 1000m, 13/xii/1995, GM, DC & GT; Mt Spurgeon, Sandy Creek, 16°28'S 145°12'E, 1100m, GM; Hughes Rd, Topaz, 17°26'S 145°42'E, 650m, 4/xii/1993, GM & Janetzki; Wallaman Falls Rd junetion, 18°39'S 145°52'E, 650m, 5/ii/1996, GM; "Camp Milo" Cooloola, (26°00'S 153°00'E), 17-28/viii/1970, EC Dahms, under bark, standing tree; Mt Lewis Rd, 29km from Highway, 16°31'S 145°16'E, 1210m, 29/xi/1997, GM; Rex Ra. summit, 16°32'S 145°23'E, 400m, 18/v/1998, GM; Gadgarra Rd, 5km E Lake Eacham, (17°17'S 145°38'E), 700m, 9/xii/1989, GM, GT & Janetzki; Peeramon Serub, 17°19'S 145°37'E, 750m, 9/xii/1995, GM; Kirrama Ra., Douglas Creek Rd, (18°06'S 145°42'E), 850m, 10-12/xii/1986, GM, GT and Hamlet; Paluma Dam Rd, Birthday Ck, (18°58'S 146°09'E), 800m, 17/xi/1990, GM & Seymour; 3km SE Coen, 13.55°S 143.11°E, 24/vi/1993, ID Naumann and P Zborowski, at light (ANIC); Boonjie, 13km ESE Malanda, (17°24'S 145°45'E), 700m, 8/xii/1988, GM & GT; Pease's Lookout, Eungella, 21°07'S 148°31'E, 900m, 17/xi/1992, GM, GT & Janetzki; 3km W Bones Knob, 17°13'S 145°25'E, 1100m, 10/xii/1995, GM, DC & GT; Packers Ck via Portland Roads, (12°38'S 143°25'E), 6/xii/1985, GM & DC; Gurgeena Plateau, 25°27'S 151°23'E, 360m, 22/viii/1998, GM; 0.5km SE Mt Spurgeon, 16°27'S 145°12'E, 1180m, 21/xi/1997, GM; Mt Fisher summit, 17°33'S 145°33'E, 8/ii/1999, GM; 3km S Mt Deongwar, 27°14'S 152°15'E, 450m, 27/xii/1998, GM; Mt Abbot, top camp, 20°06'S 147°45'E, 800m, 8/xii/1996, GM; Lamington, O'Reillys, 14/i/1995, site M-2; WESTERN

AUSTRALIA: Kangaroo Gully, 1km NW Brookton Highway, 32°07'S 116°09'E, 260m, 5/i/2000, CJ Burwell knockdown, pyrethrum polyporus fungi on logs; AUSTRALIAN CAPITAL TERRITORY: Canberra, Black Mtn, (35°16'S 149°06'E), 600m, 7-12/iii/1980, A Newton and M Thayer, dry sclerophyll, window trap (AMNH). NEW SOUTH WALES: Concord, (33°50'S 151°05'E), December 1950, A Dyce; CHRISTMAS ISLAND: near Central Area workshop, 10.29°S 105.37°E, 13-28/iv/1989, JF Lawerence on lichen covered bark mainly at light (ANIC); near Central Area workshop, 10.29°S 105.37°E, 25/iv/1989, JC Cardale on lichen covered bark (ANIC).

DIAGNOSIS. Body elongate-ovoid; AII narrow; stramineous marking on apex of scutellum; fuscous markings on anterior two thirds of cuneus; fuscous marking on posterior margin of hemelytra; fore- and metafemora with broad medial black annulation and narrow subapical black annulations (Fig. 2I); and aedeagus with a single basal sclerite. *Peritropis punctatus* is distinguished from *P. aotearoae* (cf. Figs 2C & 2I) by the very broad fuscous annulation on the hind femora, and from *P. roebucki* by the absence of stramineous apices of the fore- and metafemora (cf. Fig. 2I & 2J).

REMARKS. *Peritropis punctatus* is a widespread species (Fig. 5), occurring along most of eastern coastal Australia from the ACT to northern Qld, extending into Papua New Guinea. It also occurs in the south-western corner of WA and Christmas Island. Specimens have been predominately collected by pyrethrum knockdown on dead trees and logs, indicating a possible association with fungal mycelia. Several specimens from Western Australia were also collected by pyrethrum knockdown from a log encrusted with polyporus fungi, a habitat association consistent with the proposition of mycetophagy as a general habit for cylapines (Wheeler, 2001).

Peritropis roebucki sp. nov.
(Figs 1A-E, 1G, 2J, 4, 11, 12A-D, 13A-B)

ETYMOLOGY. This species is named after Roebuck Plains near Broome in Western Australia where many of the type specimens were collected.

MATERIAL. Holotype: WESTERN AUSTRALIA: 1♂, Roebuck Plains via Broome, (18.02°S 122.42°E), 10-13 December 1999, ex light trap, S Kniveton (AM). Paratypes: WESTERN AUSTRALIA: Roebuck Plains via Broome, ex light trap as follows; 3♂♂ 1♀, same data as holotype; 1♂, 30 Jan. 1998 – 4 Feb. 1998, C Broekway; 2♂♂, 30 Dec. 1997 – 2 Jan. 1998, C Johnstone; 1♂, Wyndham, (15.47°S 128.10°E), 8 Dec. 1999, ex light trap, T Vinnicombe (AM); 1♀, "Moola Bulla" via Halls Creek, (18.2°S 127.5°E), 15-18 Mar. 1999, ex light trap, M and J Shaw (all AM).

DIAGNOSIS. *Peritropis roebucki* is distinguished by the following combination of characters: antennae brown with stramineous mottling; pronotum with distinct fuscous and stramineous markings; hemelytra, scutellum fuscous, and membrane grey with stramineous mottling; femora mostly stramineous with subdistal fuscous annulation (Fig. 2J); aedeagus with two endosomal sclerites (Fig. 12D); sclerotised rings basally tapered (Fig. 13 A); and, inter-ramal sclerite laterally thickened (Fig. 13B). *Peritropis roebucki* is distinguished from *P. postlei* by the less dense covering of adpressed, pale, scale-like setae on the dorsum. The distinctive pattern of fuscous annulations on the femora of *P. roebucki* (cf. Fig. 2C, 2I and 2J) distinguishes it from species such as *P. aotearoae* and *P. punctatus*.

DESCRIPTION. *Colouration.* Head: stramineous, occasionally with fuscous to red mottling. Antennae: AI brown with moderate stramineous mottling, basal third stramineous; AII brown with moderate stramineous mottling; AIII-AIV brown to fuscous. Pronotum: brown with intense stramineous mottling; medial callosite region stramineous with weak red-orange mottling. Mesoscutum: brown, posteriorly with weak stramineous mottling. Scutellum: brown with weak stramineous mottling, posterior third with 2 almost contiguous, indistinct, stramineous markings. Hemelytra: brown with weak stramineous mottling, usually with large circular stramineous markings near anterior lateral margins and costal fracture; membrane grey with stramineous mottling. Legs: stramineous, forefemora with broad fuscous annulation medially, proximal margin strongly concave; meso- and metafemora with narrow fuscous annulation on distal third; tibiae stramineous with brown mottling to fuscous with stramineous mottling (Fig. 2J).

Dorsal texture. Head, pronotum and hemelytra rugulose.

Vestiture. Head and body with moderately dense distribution of simple, fine, pale, erect setae.

Structure. Macropterous, elongate. Head: posterior margin moderately concave; vertex medially sulcate; antennal insertions contiguous with eyes. Antennae: AI tapered basally; AIII-AIV shortened and slender. Eyes: reaching gula and contiguous with posterior margin of head. Pronotum: transverse, trapeziform; collar obsolete; callosite region moderately developed, medial foveae

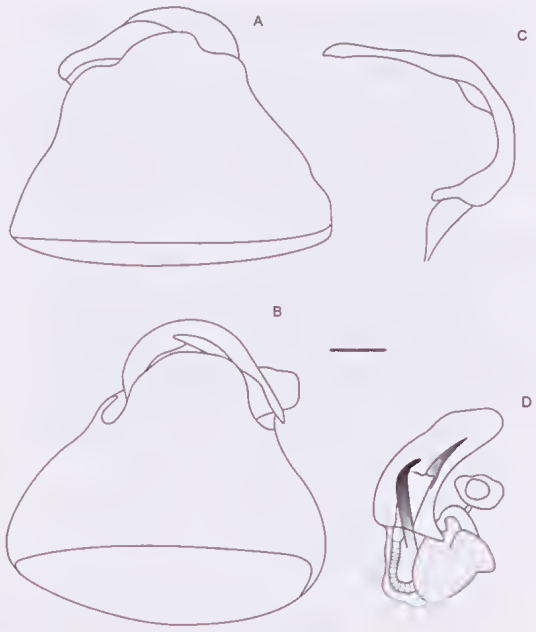


FIG. 12. *Peritropis roebucki* sp. nov. male genitalia. A, pygophore ventral view. B, pygophore dorsal view. C, left paramere. D, aedeagus with theca. Scale bar 0.1mm.

obsolete; anterior angles obtuse, lateral margins moderately explanate, posterior margin weakly bisinuate. Mesoscutum: prominent, strongly convex. Scutellum: flat, posterior third moderately declivent. Hemelytra: clavus moderately declivent with narrow ridge medially; embolium moderately explanate; costal fracture weakly developed. Thoracic pleura: proepisternum anteriorly orientated; proepimeron deeply depressed medially; peritreme of metathoracic glands, weakly fusiform, medially orientated; spiracle exposed. Male genitalia (Fig. 12A-D): pygophore subconical (Fig. 12A); genital opening large (Fig. 12B), circular; left paramere absent from specimen dissected; right paramere (Fig. 12C) elongate and strongly curved; aedeagus (Fig. 12D) with secondary gonopore elongate, trough-like; ductus seminis moderately elongate and sclerotised, two endosomal sclerites present. Female genitalia (Figs 13A-B):, sclerotised rings (Fig. 13A) large, elliptical, and tapered basally; posterior wall (Fig. 13B) with lateral margins of inter-ramal sclerite thickened.

Measurements. 5♂♂ BL 1.72-2.94, HW 0.44-0.51, IOD 0.16-0.18, HL 0.40-0.43, PL 0.27-0.31, PW 0.63-0.78, AII 0.63-0.74, LL 1.35-1.52; 2♀♀ BL 1.84-2.94, HW 0.55, IOD 0.26, HL 0.52, PL 0.38, PW 0.72, AII 0.80, LL 1.64.

REMARKS. *Peritropis roebucki* occurs in the Kimberley region of WA (Fig. 4).

CONCLUSIONS

The large and diverse Cylapinae genus *Peritropis* Uhler, which now comprising 62 species worldwide, was previously known from Australia by only a single species (*P. kotejai* Gorczyca, 1997a). This work establishes a significant presence for this cosmopolitan genus in Australia. It is now known to occur in all Australia states and territories, except Victoria and Tasmania, ranging from monsoonal northern zones and tropical rainforest to arid and temperate regions. The distributions of several species thought to be restricted to islands in the Pacific Ocean, such as New Caledonia and New Zealand, have been significantly expanded to include Australia, and, in the case of *P. aotearoae* and *P. punctatus*, Christmas Island. There is some uncertainty about the identity of the Christmas Island species

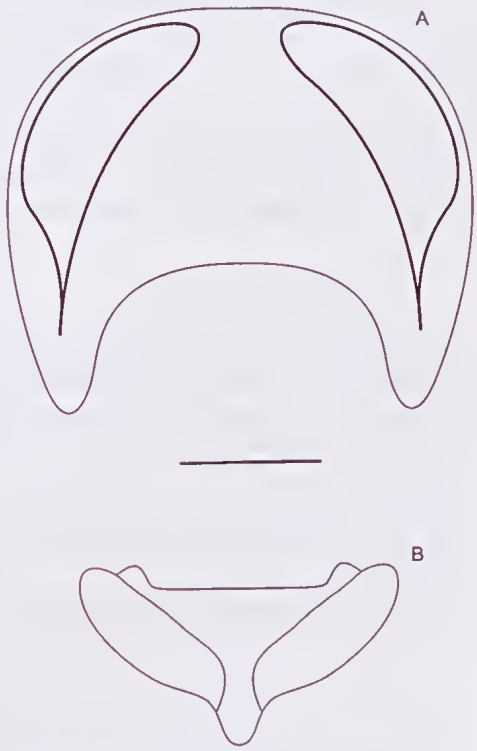


FIG. 13. *Peritropis roebucki* female genitalia. A, sclerotised rings B, posterior wall. Scale bar 0.1mm.

P. listeri, and comparison with *P. aotearoae* is required.

The fuscous patterning of the tibiae and femora (Fig. 2A-J) frequently provides the most straightforward means of distinguishing the Australian species of *Peritropis*. Four species (*P. albaspecca*, *P. kotejai*, *P. basseti* and *P. novocaledonicus*) have a completely, or mostly fuscous femora and only minor stramineous markings medially on the tibiae (Fig. 2D). This colouration easily separates these four from the rest of Australian species which show varying patterns of fuscous annulations on the femora and tibiae. These other Australian species each have their own distinctive colour patterns on the fore-, meso- and metafemora, as shown in Figure 2.

ACKNOWLEDGEMENTS

This work was supported by the Australian Biological Resources Study. We thank Ms Hannah Finlay for her habitus illustrations of *Peritropis adusta* and *P. roebucki*. Ms Sue Lindsay provided technical support for the scanning electron microscopy. The following curators are thanked for the loan of specimens: Dr Randall T. Schuh (AMNH), Mr Gordon Nishida (BPBM), Dr Graham Brown (NTM), Dr Geoff Monteith (QM), Dr Gordon Gross and Ms Jan Forrest (SAMA), Dr Thomas J. Henry (USNM) and Dr Terry Houston (WAM). Thanks also to Dr Tony Postle (Australian Quarantine Inspection Service) who provided specimens that were fundamental to this study.

LITERATURE CITED

BERGROTH, E. 1925. On the annectant bugs of Messrs. MacAtee and Malloch. Bulletin of the Brooklyn Entomological Society 20: 159-164.

BOLTE, K.B. 1996. Techniques for obtaining scanning electron micrographs of minute arthropods. Proceedings of the Entomological Society of Ontario 127: 67-87.

CARVALHO, J.C.M. 1956. Insects of Micronesia: Miridae. Bishop Museum., Honolulu, Insects of Micronesia 7: 1-100.

1957. A catalogue of the Miridae of the world. Part I. Arquivos do Muscu Nacional, Rio de Janeiro 44: 1-58.

1981. Analecta Miridologica, V: observations on type specimens in the collection of the British Museum of Natural History (Hemiptera. Miridae). Revista Brasileira de Biologia. 41:1-8.

CARVALHO, J.C.M. & LORENZATO, L.M. 1978. The Cylapinae of Papua New Guinea (Hemiptera: Miridae). Revista Brasileira de Biologia 38:121-149.

CASSIS, G. 1995. A reclassification and phylogeny of the Termatophylini (Heteroptera: Miridae: Deraeocorinae), with a taxonomic revision of the Australian species, and a review of the tribal classification of the Deraeocorinae. Proceedings of the Entomological Society of Washington 97(2): 258-330.

CASSIS, G. & GROSS, G.F. 1995. Zoological Catalogue of Australia. Coleorrhyncha to Cimicomorpha. Volume 73.A. Melbourne: CSIRO Australia.

CASSIS, G., SCHWARTZ, M.D. & MOULDS, T.A. (2003). Systematics and new taxa of the *Vannius* complex (Hemiptera: Miridae: Cylapinae) from the Australian Region. Memoirs of the Queensland Museum 49(1): 123-151.

GORCZYCA, J. 1997a. A new species of the genus *Peritropis* Uhler, 1891, from Australia (Heteroptera: Miridae: Cylapinae). Genus 8(3-4): 555-558.

1997b. A new species of the genus *Peritropis* Uhler, 1891, from New Caledonia (Heteroptera: Miridae: Cylapinae). Genus 8(3-4): 559-561.

1997c. *Xenocylapidius tamasi* gen. et sp. nov. from New Caledonia (Heteroptera: Miridae: Cylapinae). Polskie Pismo Entomologiczne 66: 177-184.

1998. A new species of *Peritropis* Uhler from Malawi (Heteroptera: Miridae: Cylapinae). Annals of the Natal Museum 39: 199-202.

1999. A new remarkable species of *Peritropis* Uhler from Tanzania (Heteroptera: Miridae: Cylapinae). Genus 10: 21-23.

2000. A systematic study on Cylapinae with a revision of the Afrotropical Region (Heteroptera, Miridae). Katowice: Wydawnictqo Uniwersytetu Slaskiego 176 pages

GORCZYCA, J. & EYLES, A.C. 1997. A new species of *Peritropis* Uhler, the first record of Cylapinae (Heteroptera: Miridae) from New Zealand. New Zealand Journal of Zoology 24: 225-230.

HENRY, T.J. & WHEELER, A.G. Jr 1988. Family Miridae Hahn, 1833 (= Capsidae Burmeister, 1835). The plant bugs. Pages 251-507, in Henry, T.J. & Froeschner, R.C. (eds). Catalog of the Heteroptera, or True Bugs, of Canada and the Continental United States. E.J. Brill: Leiden.

IZZARD, R.J. 1936. The Hemiptera of Christmas Island. Annals and Magazine of Natural History (10)17:577-600.

KERZHNER, I.M. 1972. New and little known Heteroptera from the Far East of the USSR. Trudy Zoologischeskogo Instituta Akademiya Nauk SSSR 52: 276-295.

KERZHER, I.M. & JOSIFOV, M. 1999. Cimicomorpha II. Miridae. Pages xiv, 1-576, in Aukema, B. &

Rieger, C. (eds). Catalogue of the Heteroptera of the Palaearetie Region. The Netherlands Entomologieal Soeiety: Amsterdam.

SCHMITZ, G. 1970. Contribution a la faune du Congo (Brazzaville). Mission A. Villiers et A. Descarpentries. XCVIII. Hemipteres Miridae et Isometopidae (1re partie). Bulletin de l'Institut Franeais de l'Afrique Noire 32A: 501-530.

SCHUH, R.T. 1995. Plant bugs of the World (Inseeta: Heteroptera: Miridae). Systematie eatalog, distributions, host list, and bibliography. The New York Entomologieal Soeiety: New York.

SWEARINGEN, M., HEADRICK, D. & BELLOWS, T. 1997. Comparison of fixation and drying proeedures for seanning eleetron mieroseopy among inseet body types. Proeeedings of the Entomologieal Soeiety of Washington 99(3): 513-522.

UHLER, P.R. 1891. Observations on some remarkable forms of Capsidae. Proeeedings of the Entomologieal Soeiety of Washington 2:119-123.

WHEELER, A.G. Jr 2001. Biology of the Plant Bugs (Hemiptera, Miridae). Pests, Predators, Opportunists. Cornell University Press: Ithaea.

YASUNAGA, T. 2000. The mirid subfamily Cylapinae (Heteroptera: Miridae) or fungal inhabiting plant bugs in Japan. Tijksehrift voor Entomologie 143: 183-209.

PARASITE COMMUNITIES AND DIET OF *CORIS BATUENSIS* (PISCES: LABRIDAE) FROM LIZARD ISLAND, GREAT BARRIER REEF

GABRIELA MUÑOZ AND TOM H. CRIBB

Muñoz, G. and Cribb, T.H. 2006 11 10: Parasite communities and diet of *Coris Batuenss* (Pisces: Labridae) from Lizard Island, Great Barrier Reef. *Memoirs of the Queensland Museum* **52**(1): 191-198. Brisbane. ISSN 0079-8835.

Parasite infracommunities of the wrasse *Coris batuensis* (Bleeker, 1857) were analysed, and the relationship between endoparasites, diet, and host body weight inferred. Thirty-two fish were collected from Lizard Island, Australia. Percentage frequency of occurrence of prey categories in the gut was determined and abundance, prevalence and species richness of parasites were calculated. Fish mainly ate snails, bivalves and crustaceans and this did not vary with body weight. Thirty-one fish were parasitised with at least one of 21 taxa of parasites (4 ectoparasite and 17 endoparasite species), with an average of 4 species and 47 individuals per host. Tetraphyllidean cestode larvae were the most common and abundant group. Parasite life cycles are not known in detail, but small crustaceans, such as copepods and amphipods, are likely to be intermediate hosts for the cestodes, nematodes and digeneans found in *C. batuensis*. Molluses, although frequent in the diet, may not be transmitting any parasite species. Numbers of prey and parasite species richness were not correlated. Composition, abundance and species richness of the parasite fauna were similar in hosts with different body weight, corresponding with *C. batuensis* having a similar diet throughout life. ❐ *Coris batuensis, wrasse, parasites, diet, coral reef, Australia.*

Gabriela Muñoz, Universidad de Valparaiso, Facultad de Cienciias del Mar y de Recursos Naturales, Casilla 5080 Reñaea, Viña del Mar, Chile. email: gabriela.munoz@uv.cl; Tom Cribb, School of Moleeular and Microbial Sciences, Parasitology Group. The University of Queensland, Brisbane 4072, Australia; *8 July 2005.*

Parasite communities can be affected by many variables from the environment (physical or chemical conditions) and from the host (ecological characteristics) (Rohde, 1993). Thus, the study of parasite communities of fishes has been used as a tool to discriminate host populations (e.g. George-Nascimento, 2000), infer trophic web interactions (e.g. Marcogliese, 2003) and identify contaminated habitats (e.g. Khan & Thulin, 1991; Schludermann et al., 2003). Moreover, the body size and diet of the hosts are considered one of the major ecological variables that relate to the variation of parasite communities (e.g. Sasal et al., 1999; Muñoz et al., 2002). In general it is concluded that, relative to a small body, a large body will offer more resources to parasites and will have been available for longer for parasite species to be acquired (Muñoz et al., 2002). Most endoparasites need intermediate hosts in their life cycles, so that variations in parasite communities are also likely to be associated with diet variation (e.g. Valtonen & Julkunen, 1995). Variation in diet composition can also be associated with ecological characteristics of hosts such as foraging behavior and seasonal changes. These factors may all affect parasite composition so that their exploration can provide a better understanding of the parasite community structure (Valtonen & Julkunen, 1995; Knudsen et al., 2004).

This study considers the body size and the diet of a fish species, the batu cori *Coris batuensis* (Bleeker, 1857), and explores their relationship to the number of parasites and their composition. This fish belongs to the Labridae, which is the second most species rich family of fishes in the Great Barrier Reef (GBR) (Randall et al., 1997). Surprisingly, little is known about parasite communities of such fishes. Lester & Sewell (1989) listed the parasites known for six species of labrids on the GBR. Later, Grutter (1994) and Grutter & Poulin (1998) studied the ectoparasite assemblages of some wrasse species but few studies have considered whole parasite communities (Muñoz & Cribb, 2005). Additional taxonomic and ecological studies described and recorded endoparasite species of these fishes (e.g. Cribb & Bray, 1999; Chambers et al., 2000; Pichelin & Cribb, 2001; Muñoz et al., 2006).

Coris batuensis is a small wrasse that reaches no more than 17cm in length (Randall et al., 1997). It is abundant at Lizard Island and principally inhabits the reef base and sandy patches (Green, 1996). There are no published studies about the diet

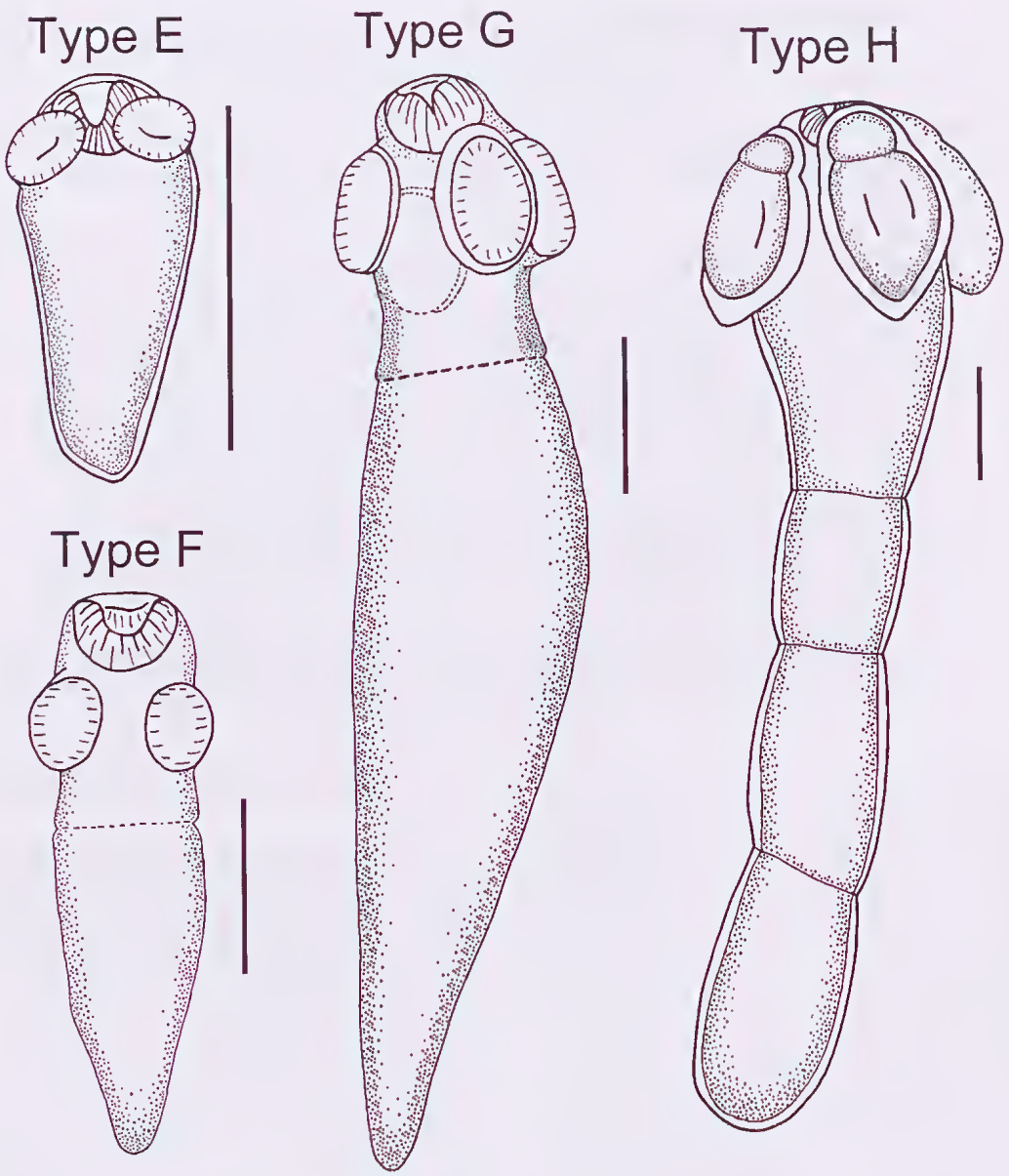


FIG. 1. Larval stages of four tetraphyllideans from *Coris batuensis*, scale-bars: 0.1 mm

or the parasite communities of *C. batuensis*. Other *Coris* species are said to prey on crustaceans and gastropods (Sano et al., 1984).

Our study aimed to identify all the metazoan parasite species (external and internal) found in *Coris batuensis*. We determined the identity and frequency of prey categories to consider what organisms may be intermediate hosts for the endoparasites found in this fish. We then combined analysis of the diet and endoparasite infracommunities of *C. batuensis* to investigate possible changes in relation to fish body weight.

MATERIALS AND METHODS

Between January 2003 and May 2004, 32 individuals of *Coris batuensis* were collected from the Lizard Island (14° 40'S, 145° 28'E), GBR, Australia. The fish were mainly caught by net while diving and sometimes by speargun while snorkelling.

In the laboratory the total length and the weight of each fish was measured. Fish were then examined for ectoparasites on the body surface and gills, and for endoparasites in the body cavity, gall bladder and gut. At the same time, the food contents from the gut were recorded. Parasites and gut contents were fixed in 5% formaldehyde for later examination.

Food contents were determined to family, where possible, according to Wilson (1993) and Abbott & Dance (1998) for molluscs and Jones & Morgan (2002) for crustaceans. The frequency of occurrence for each prey category was calculated as the number of fish that had a specific prey category, divided by the total number of fish with gut contents and expressed as a percentage.

Most parasites (platyhelminths) were stained in Mayer's haematoxylin and mounted in Canada balsam. Copepods and nematodes were cleared with chlorolactophenol for observations under light microscopy. Copepods were identified following Cressey & Cressey (1989) and monogeneans following Hayward (1996). Larval stages of tetraphyllidean cestodes were identified only as morphotypes according to Chambers et al. (2000); trypanorhynch cestodes were identified according to Campbell & Beveridge (1994, 1996). Digeneans were identified following Bray & Cribb (1989) and Bray et al. (1993); nematodes were identified following Olsen (1952) and Ogden (1969). Species richness, abundance and prevalence of parasites were calculated according to Bush et al. (1997).

Fish were collected during several seasons. To ensure seasonality was not affecting the results, we applied Kruskall-Wallis tests (see Zar, 1996) to compare abundances and species richness of parasites in hosts collected in different seasons.

Parametric linear correlations (e.g. Pearson correlations) were used to relate number of dietary categories and parasitological descriptors of parasites to the host body weight (Zar, 1996). This was applied only for endoparasites which are generally transmitted in food. Because crustaceans are probably the intermediate hosts for most of the endoparasites, the number of crustacean categories was correlated with host body weight. In order to remove the effect of host body weight in these correlations, residuals of linear regressions between descriptors (species richness and abundance of parasites vs host body weight) and diet categories (total items and crustacean items vs host body weight) were utilised to relate parasitological descriptors and diet. A significance level of 0.05 was used for statistical analyses.

RESULTS

Twenty-three of 32 individuals of *Coris batuensis* had food in the gut. The diet was comprised of small prey items, no more than 10 mm in length. Molluscs, crustaceans and annelids occurred at frequencies of 100, 74 and 13% respectively. Snails of the family Dialidae, which are small and abundant in lagoons of coral reefs (Wilson, 1993), were the most common food categories (Table 1). Snails, bivalves and crustaceans were all found in small and large fish, and were present at 5–10 prey categories per fish. The number of prey categories did not increase with the fish body weight (Pearson correlation: n= 23, r= 0.18, P= 0.40). The number of crustacean categories did not increase with host body weight (n= 23, r= 0.05, P= 0.82).

Thirty-one fish were parasitised with at least one of 17 parasite species: 4 were ectoparasites and 13 were endoparasites (Table 2). Two ectoparasite species were gathered from the body surface and another 2 species were from the gill filaments. Thirteen species were collected from the gut and 4 species were from the body cavity including the gall bladder (Table 2). Because the samples were collected at different seasons, the sampling effect on species richness and abundance of parasites was evaluated comparing the averages of these descriptors between sampling time (summer, autumn and late winter). There were no significant differences in the total abundances and species richness of parasites among the three seasons (Kruskall-Wallis results using adjusted probabilities for small sample size: n= 32, $H_{(2)}$= 0.86, P= 0.65 for species richness; $H_{(2)}$= 0.77, P= 0.68 for abundance). There were also no differences in parasite composition; the most abundant and frequent parasites (Table 2) were present in all three seasons considered. Thus, sampling time was not an important variable in the parasite infracommunities of *C. batuensis*. Consequently, the following analyses are based on the combined fish sample.

The mean infracommunity species richness was 3.9 species and the mean abundance was 46.7 parasites per host. The most common parasites were cestode larvae. Eight morphotypes of tetraphyllideans were distinguished (Table 2). In this study each type was considered as a species because they were clearly distinguishable one another and there was no significant

TABLE 1. Prey categories and frequency of occurrences (OF) in gut contents of 23 individuals of *Coris batuensis*.

PHYLUM Class, Superorder or Order	Suborder or Family	OF (absolute)	OF (%)
ANNELIDA	Polychaeta	3	14.3
MOLLUSCA			
Gastropoda	Bullidae	1	4.4
	Cheritidae	4	17.4
	Dialidae	22	95.7
	Eulinoidae	1	4.4
	Naticidae	3	13.0
	Eggs (from snails?)	1	4.4
Bivalvia	Cardiidae	5	21.7
	Mytiloidea	4	17.4
	Veneridae and Tellinidae	8	34.8
	Bivalve (unidentified)	5	21.7
Polyplacophora		5	21.7
ARTHROPODA			
Amphipoda		6	26.1
Copepoda	Calanoida	2	8.7
	Harpacticoida	1	4.4
Isopoda		6	26.1
Ostracoda		4	17.4
Peracarida	(unidentificd)	1	4.4
Tanaidacea		5	21.7
Decapoda	Brachyura	6	26.1
Pycnogonida		1	4.4
Insecta	Chironomidae (larvae)	2	13.0
CNIDARIA	(Corals)	1	4.4

variation in the morphology within each group. Tetraphyllidean types A, B, C and D correlated to types 1, 4, 6 and 10 respectively from the study by Chambers et al. (2000). The other types E–H have not been described previously so their morphologies are shown in Fig. 1. Voucher specimens of these 4 tetraphyllidean morphotypes were deposited in the Queensland Museum: G225273 (Tetraphyllidea type E), G225274 (Tetraphyllidea type F), G225275 (Tetraphyllidea type G), G225276 (Tetraphyllidea type H). Tetraphyllidea Type B was the most prevalent parasite, whereas Tetraphyllidea Type E was the most abundant (Table 2).

The body weight of *C. batuensis* varied between 3.4 and 43.6g, corresponding to lengths of 5.8 and 14cm. There was a correspondence between body weight and maturity of the fish because small fishes were always juveniles whereas all large fish were adults. Species richness and abundance of parasites were significantly correlated (n=32, r= 0.59, P< 0.003). Neither the species richness of parasite community (Pearson correlation: n= 32, r= -0.32; P= 0.08) nor the abundance (Pearson correlation: n= 32, r= -0.05; P= 0.79) was related to host body weight. Three cestode species had high prevalences, tetraphyllideans types B and G, and *Pterobothrium australiense* (Table 2). The abundance of tetraphyllidean type B and *P. australiense* was not correlated with host body weight (Pearson correlations, n= 32: P= 0.11, P= 0.21, respectively for each species). However, Tetraphyllidea type G was negatively correlated with host body weight (n=32, r= -0.47, P= 0.006).

Species richness and abundance of endoparasites were not significantly correlated to the total number of diet categories (n=23, P> 0.55 for richness and abundance) and crustacean categories (n= 23, P> 0.46 for richness and abundance). There were no significant correlations when the residuals of the linear regressions after parasitological descriptors and number of diet categories were

TABLE 2. Species, maturity stages (MS; a: adults, l: larvae), number of parasites (NP), prevalence (P%), abundance (ABU) and standard deviation (s.d.), and site of parasites from *Coris batuensis* (n= 32) collected at Lizard Island.

Parasite group	Species	MS	NP	P(%)	ABU	s.d.	Site
ECTOPARASITES							
MONOGENEA	*Polylabris* sp.	a	7	9.4	0.22	0.71	Gills
ISOPODA	*Guathia* sp.	l	39	40.6	1.22	2.51	Body surface, gills
COPEPODA	*Orbitacolax williamsi* Cressey & Cressey, 1989	a	2	6.3	0.06	0.25	Body surface
	Chondracanthidae gen. sp.	l	1	3.1	0.03	0.18	Gills
ENDOPARASITES							
TREMATODA	*Helicometra fasciata* (Rudolphi, 1819)	a	9	18.8	0.28	0.63	Intestine
	Diplobulbus minuta Pritchard, 1966	a	3	6.3	0.09	0.39	Intestine
	Macvicaria sp.	a	16	15.6	0.50	1.44	Intestine
	Lecithaster stellatus Looss, 1906	a	1	3.1	0.03	0.18	Intestine
	Lecithaster sp.	a	2	6.3	0.06	0.25	Intestine
CESTODA	Tetraphyllidea Type A	l	23	31.3	0.72	1.71	Intestine, rectum
	Tetraphyllidea Type B	l	98	75.0	3.06	2.95	Intestine, rectum, gall bladder
	Tetraphyllidea Type C	l	18	28.1	0.56	1.24	Rectum
	Tetraphyllidea Type D	l	1	3.1	0.03	0.18	Intestine
	Tetraphyllidea Type E	l	3	6.3	0.09	0.39	Rectum
	Tetraphyllidea Type F	l	2	3.1	0.06	0.35	Rectum
	Tetraphyllidea Type G	l	1,212	53.3	37.88	65.07	Intestine
	Tetraphyllidea Type H	l	1	3.1	0.03	0.35	Gall bladder
	Pterobothrium australiense Campbell & Beveridge, 1996	l	31	37.5	0.97	1.53	Body cavity
	Pseudonybelinia sp.	l	5	6.3	0.16	0.63	Pericardial cavity
NEMATODA	*Spirocamallanus* sp.	a	13	25.0	0.41	0.91	Intestine
	Heliconema sp.	l	7	3.1	0.22	1.24	Body cavity
TOTAL			1,494		46.69	65.89	

first correlated with the host body weight (n= 23, $P > 0.52$ for all linear regressions).

DISCUSSION

Even though *Coris batuensis* is a small fish species, it exhibited a high species richness and abundance of parasites. However, some parasite species were very infrequent and in low number (only one specimen of Chondracanthidae, Tetraphyllidea D and H, and *L. stellatus*, Table 2), so that they may not be common parasites of *Coris batuensis*. Species richness and abundance of parasites do not vary with the host body weight, apparently because small and large fish live in the same habitat (Green, 1996) and eat similar prey (this study).

The absence of a relationship between average parasite species, richness and abundance and host body weight suggests that there is no accumulation of parasites in the host over time.

Probably most or all the parasite species have short life spans and are turned over continually. The parasites that are encysted, principally in muscles and body cavity, cannot be released from the host and therefore may accumulate in the host body. The lifespan of encysted parasites may be longer than those of gut parasites, although their abundance was generally lower (Table 2). Several published studies have found high abundance of parasite as a function of large host body size (e.g. Grutter & Poulin, 1998; Lo et al., 1998; Muñoz & Cribb, 2005), although this is not always the rule (e.g. Muñoz et al., 2006). A large host body can provide more resources for parasites; however, the arrival and population growth of parasites may not depend on resources but may depend on the number of parasites able to reach the host body (Olsen, 1974). This can be seen specifically in Tetraphyllidea type G which significantly decreased in abundance with the host body weight. This indicates that body size of the host as representative of resources, space and food, is not the main determinant of the parasite recruitment in the fish. Consequently, other characteristics, such as physical-chemical conditions and immune response, may act as determinant factors of parasite recruitment. Juvenile fish may differ from adults in internal environmental conditions, so that settlement of some parasite species may be better in juveniles and other in adult hosts (Rohde, 1993). Other explanations are that juvenile fish may be more susceptible to infection by Tetraphyllidea type G and that an immune response occurs after a certain degree of infection (Wakelin, 1984).

Most endoparasites found here were larvae that reach the fish via its diet. However, no relationship was found between endoparasites and diet. The route of transmission can be affected by multiple factors: prey infected with parasites, rate of infected prey eaten by the fish and number of parasites that may finally be recruited in the host body. Moreover, the life cycle of most marine parasites remains unknown. We suspect that molluscs, although important in the diet of *Coris batuensis*, may not (directly) transmit any of the parasite species. However, small crustaceans (mainly zooplankton and decapods) are probably involved in the life cycle of most of the endoparasite species reported here.

There are two other factors that mitigate against finding an association between parasite and diet. First, there were limitations in the determination of frequency of diet categories; molluscs have hard shells that are not digested, so that their collection and identification is relatively easy in comparison to small crustaceans. Thus, although there were a large number of molluscs categories in the diet of *C. batuensis*, crustaceans may be more common in frequency and in species than the survey showed. Second, parasites exhibit longer permanence time in the digestive tract than diet, so that parasites do not necessarily reflect the present diet of the host (Muñoz et al., 2002).

However, the lack of association between parasites and diet suggests that apparently juvenile and adult fish have similar diet (no correlation between parasitological descriptors, host body weight, and host diet). Also, juveniles and adults live in the same habitats (Green, 1996). Zooplankton also constitutes the main diet for larval fish (Marcoglicse, 1995), so it is possible that zooplankton is a regular diet category throughout the life of *C. batuensis*. All these analyses and inferences suggest that the lack of association between diet and parasites is real, and not because the confounding factors such as difficulties in the determination of prey diet and the difference in the lifespan of diet and host. In short, we conclude that *C. batuensis* has much the same diet throughout most of its life and, because of that, a similarly unchanging parasite composition.

As mentioned above, zooplankton probably transmits most of the parasites found in *C. batuensis*. In fact, zooplankton is an important component in the life cycle of many parasites because a large number of species have a planktonic life (Marcoglicse, 1995). This section is focused on indirect inference of the invertebrate hosts of the endoparasites of *C. batuensis*. These inferences consider the diet of the fish and the generalised life cycles of congeneric species of parasites.

Trematodes (five species) were from two families, Opecoelidae and Lecithasteridae. Opecoelids overwhelmingly use arthropods (crustaceans and insects) as second intermediate hosts; the use of vertebrates and molluscs is exceptional. Of the three opecoelid genera reported here, life cycles are known only for species of *Helicometra*. *Helicometra gibsoni* infects alphaeid shrimps as second intermediate hosts (Meenakshi et al., 1993). Both lecithasterids reported here belong to *Lecithaster*. Koie (1989) showed that *Lecithaster gibbosus* uses copepods as second intermediate hosts. We therefore conclude that probably all of the trematode infections are acquired by ingestion of infected crustaceans.

Only one complete life cycle is known for a trypanorhynch; *Lacistorhynchus dollfusi* has copepods as first intermediate hosts (Sakanari & Moser, 1989). These are eaten by small fish in which plerocercoids develop. We conclude that the *Coris batuensis* would become infected with *Pterobothrium* and *Pseudonybelinia* by eating small crustaceans.

Few complete life cycles are known for tetraphyllideans, but, where known, procercoids appear to infect small crustaceans much as described above for trypanorhynchs (Antamaran & Krishawamy, 1958; Jareeka & Burt, 1984).

The *Spirocamallanus* sp. and *Heliconema* sp. probably enter this fish through crustaceans such as copepods and shrimps (Anderson, 2000). *Heliconema* nematodes were encysted in the host body cavity indicating that *C. batuensis* may be a paratenic host. This group of nematodes (Physalopteridae) does not use a fish as second intermediate hosts.

Eleven species of endoparasites were only represented by larval stages (Table 2), which reach their sexual maturity in other fishes. In general, tetraphyllideans and trypanorhynchs mature in sharks and rays (see Sakanari & Moser, 1989; Campbell & Beveridge, 1994, Chambers et al., 2000), and nematodes of the genus *Heliconema* mature mainly in anguilliform fishes, but also in some other teleosts and elasmobranchs (Anderson, 2000). Therefore, these groups of fishes are likely predators of *C. batuensis*. In this respect, *C. batuensis* may be a significant component in the trophic and parasite webs in the Great Barrier Reef region. This fish species is not just prey for other fishes, but also constitutes an important pathway in the life cycle of several endoparasite species.

ACKNOWLEDGEMENTS

We thank Craig Hayward who helped in identifying the monogenean and the copepods found in this study.

LITERATURE CITED

ABBOTT, R.T. & DANCE, S.P. 1998. Compendium of Seashells. (Odyssey Publishing: California).

ANDERSON, R.C. 2000. Nematode parasites of vertebrates — their development and transmission. (CAB international: New York).

ANTAMARAN, S. & KRISHAWAMY, S. 1958. Tetraphyllidean larvae in the marine copepod *Eucalanus pseudattenuatus* Sewell, from the Madras Coast. Journal of the Zoological Society of India 10: 1–3.

BRAY, R.A. & CRIBB, T.H. 1989. Digeneans of the family Opecoelidae Ozaki, 1925 from the southern Great Barrier Reef, including a new genus and three new species. Journal of Natural History 23: 429–473.

BRAY, R.A., CRIBB, T.H. & BARKER, S.C. 1993. The Hemiuroidea (Digenea) of pomacentrid fishes (Perciformes) from Heron Island, Queensland, Australia. Systematic Parasitology 24: 159–184.

BUSH, A. O., LAFFERTY, K.D., LOTZ, J.M. & SHOSTACK, A.W. 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. Journal of Parasitology 83: 575–583.

CAMPBELL, R.A. & BEVERIDGE, I. 1994. Order Trypanorhyncha Diesing, 1863. Pp. 51–148. In Khalil, L.F., Jones, A. & Bray, R.A. (eds). Key to the cestode parasites of vertebrates. (CAB International, University Press Cambridge).

1996. Revision of the Family Pterobothriidae Pintner, 1931 (Cestoda: Trypanorhyncha). Invertebrate Taxonomy 10: 617–662.

CHAMBERS, C., CRIBB T.H. & JONES M.K. 2000. Tetraphyllidean metacestodes of teleosts of the Great Barrier Reef, and the use of *in vitro* cultivation to identify them. Folia Parasitologica 47: 285–292.

CRESSEY, R. & CRESSEY, H.B. 1989. A new species of *Orbitacolax* (Copepoda: Bomolochidae) and redescriptions of two additional species. Canadian Journal of Zoology 67: 2902–2909.

CRIBB, T.H. & BRAY, R.A. 1999. A review of the Apocreadiidae Skrjabin, 1942 (Trematoda: Digenea) and description of Australian species. Systematic Parasitology 44: 1–36.

GEORGE-NASCIMENTO, M. 2000. Geographical variations in the jack mackerel *Trachurus symmetricus murphyi* populations in the southeastern Pacific Ocean as evidenced from the associated parasite communities. Journal of Parasitology 86: 929–932.

GREEN, A.L. 1996. Spatial, temporal and ontogenetic patterns of habitat use by coral reef fishes (Family Labridae). Marine Ecology Progress Series 133: 1–11.

GRUTTER, A.S. 1994. Spatial and temporal variations of the ectoparasites of seven reef fish species from Lizard Island and Heron Island, Australia. Marine Ecology Progress Series 115: 21–30.

GRUTTER, A.S. & POULIN, R. 1998. Intraspecific and interspecific relationships between host size and the abundance of parasitic larval gnathiid isopods on coral reef fishes. Marine Ecology Progress Series 164: 263–271.

HAYWARD, C. 1996. Revision of the monogenean genus *Polylabris* (Microcotylidae). Invertebrate Taxonomy 10: 995–1039.

JARECKA, L. & BURT, M.D.B. 1984. The cercoid larvae of *Pseudanthobothrium hanseni* Baer, 1956 and *Pseudanthobothrium* sp. (Cestoda: Tetraphyllidea) from experimentally infected harpacticoid copepods. Acta Parasitologica 29: 23–26, 2 plates.

JONES, D.S. & MORGAN, G.J. 2002. A field Guide to Crustaceans of Australian Waters. (Red New Holland, Western Australian).

KHAN, R.A. & THULIN, J. 1991. Influence of pollution on parasites of aquatic animals. Advances in Parasitology 30: 201–238.

KNUDSEN, R., CURTIS M.A., & KRISTOFFERSEN, R. 2004. Aggreation of helminths: the role of feeding behavior of fish hosts. Journal of Parasitology 90: 1–7.

KØIE, M. 1989. On the morphology and life history of *Lecithaster gibbosus* (Rudolphi, 1802) Lühe, 1901 (Digenea, Hemiuroidea). Parasitology Research 75: 361–367.

LESTER, R.J.G., & SEWELL, K.B. 1989. Checklist of parasites from Heron Island, Great Barrier Reef. Australian Journal of Zoology 37: 1001–128.

LO, C.M., MORAND, S. & GALZIN, R. 1998. Parasite diversity/host age and size relationship in three coral-reef fishes from French Polynesia. International Journal of Parasitology 28: 1695–1708.

MARCOGLIESE, D. J. 1995. The role of zooplankton in the transmission of helminth parasites to fish. Reviews in fish Biology and fisheries 5: 336–371.

MARCOGLIESE, D. J. 2003. Food webs and biodiversity: are parasites the missing link? Journal of Parasitology 89: S106–S113.

MEENAKSHI, M., MADHAVI, R. & SWARNAKUMARI, V.G.M. 1993. The life-cycle of *Helicometra gibsoni* n. sp. (Digenea: Opecoelidae). Systematic Parasitology 25: 63–72.

MUÑOZ, G., VALDEBENITO, V. & GEORGE-NASCIMENTO, M. 2002. La dieta y la fauna de parásitos metazoos del torito *Bovichthys chilensis* Regan 1914 (Pisces: Bovichthydae) en la costa de Chile centro-sur: variaciones geográficas y ontogenéticas. *Revista Chilena de Historia Natural* 75: 661–671.

MUÑOZ, G. & CRIBB, T.H. 2005. Infracommunity structure of parasites of *Hemigymnus melapterus* (Pisces: Labridae) from Lizard Island, Australia: the importance of habitat and parasite body size. Journal of Parasitology 91: 38–44.

MUÑOZ, G., GRUTTER, A.S. & CRIBB, T.H. 2006. Endoparasite communities of five fish species (Labridae: Cheilininae) from Lizard Island: How important is the ecology and phylogeny of the hosts? Parasitology 132: 363–374.

OGDEN, C.G. 1969. A revision of the genus Heliconema Travassos, 1919, Physalopteridae (Nematoda). Journal of Natural History 3: 423–431.

OLSEN, L. S. 1952. Some nematodes parasitic in marine fishes. Publication of Institute of Marine Science, University of Texas 2: 172–215.

OLSEN, O. W. 1974. Animal Parasites: Their Life Cycles and Ecology. (Dove Publications, Inc.: New York).

PICHELIN, S. & CRIBB, T.H. 2001. The status of the Diplosentidae (Acanthocephala: Palaeacanthocephala) and a new family of acanthocephalans from Australian wrasses (Pisces: Labridae). Folia Parasitologica 48: 289–303.

RANDALL, J.E., ALLEN, G.R. & STEENE, RC. 1997. fishes of the Great Barrier Reef and Coral Sea. Crawford House Publishing, Bathurst, Australia.

ROHDE, K. 1993. Ecology of Marine Parasites. 2nd edn, (CAB International: Oxon).

SAKANARI J.A. & MOSER M. 1989. Complete life cycle of the elasmobranch cestode *Lacistorhynchus dollfusi* Beveridge and Sakanari, 1987 (Trypanorhyncha). Journal of Parasitology 75: 806–808.

SANO, M., SHIMIZU, M. & NOSE, Y. 1984. Food habits of teleostean reef fish in Okinawa Island, Southern Japan. The University Museum, The University of Tokyo, Bulletin 25: 1–128.

SASAL, P., NIQUIL, N. & BARTOLI, P. 1999. Community structure of digenean parasites of sparid and labrid fishes of the Mediterranean Sea: a new approach. Parasitology 119: 635–648.

SCHLUDERMANN, C., KONECNY, R., LAIMGRUBER, S., LEWIS, J. W., SCHIEMER, F., CHOVANEC, A. & SURES, B. 2003. fish macroparasites as indicators of heavy metal pollution in river sites in Austria. Parasitology 126: S61–S69

VALTONEN, E. T. & JULKUNEN, M. 1995. Influence of the transmission of parasites from prey fishes on the composition of the parasite community of a predatory fish. Canadian Journal of fisheries and Aquatic Sciences 52: 233–245.

WAKELIN, D. 1984. Immunity of parasites. How animals control parasite infections. Edward Arnold, London.

WILSON, B. 1993. Australian Marine Shells: Prosobranch Gastropods, vols 1 & 2. (Odyssey Publishing: Western Australian).

ZAR, J.H. 1996. Biostatistical analysis. 2nd edn. Prentice-Hall, Inc. New Jersey.

A REVIEW OF *TEMNOHASWELLIA* AND *TEMNOSEWELLIA* (PLATYHELMINTHES: TEMNOCEPHALIDA: TEMNOCEPHALIDAE), ECTOSYMBIONTS FROM AUSTRALIAN CRAYFISH *EUASTACUS* (PARASTACIDAE)

KIM B. SEWELL, LESTER R.G. CANNON AND DAVID BLAIR

Sewell, K.B., Cannon, L.R.G. & Blair, D. 2006 11 10: A review of *Temnohaswellia* and *Temnosewellia* (Platyhelminthes: Temnocephalida: Temnocephalidae) ectosymbionts from Australian crayfish *Euastacus* (Parastacidae). *Memoirs of the Queensland Museum* **52**(1): 199–280. Brisbane. ISSN 0079-8835.

Temnohaswellia, containing six-tentacled and usually non-pigmented ectosymbiont worms from freshwater crayfish in Australia and New Zealand, is reviewed and 10 new species described from spiny mountain crayfish (*Euastacus* spp., Parastacidae) from eastern Australia. The sclerotic armature of the vagina was found most useful in discriminating species in this genus. Australian *Temnohaswellia* species are confined to *Euastacus* hosts, but are characterised by low level host specificity. *Temnosewellia*, with five tentacles and usually pigmented, is reviewed from *Euastacus* hosts in Australia and 31 new species are described. The sclerotic armature of the male cirrus was found most useful in discriminating species of this genus, with the vagina showing little variation. *Temnosewellia* species are not confined to *Euastacus* hosts, but on these hosts show much stricter host specificity. ❐ *Ectosymbionts, freshwater crayfish, temnocephalan, Platyhelminthes, Temnosewellia, Temnohaswellia, Euastacus, Parastacidae, Australia.*

Kim B. Sewell, Centre for Microscopy and Microanalysis, The University of Queensland, St Lucia, Queensland, 4072, (email k.sewell2@uq.edu.au); Lester R. G. Cannon, Queensland Museum, PO Box 3300, South Brisbane, Queensland, 4101; David Blair, School of Tropical Biology, James Cook University, Townsville, Queensland, 4810, Australia; 1 June 2006.

Temnocephalan worms are freshwater rhabdocoel turbellarian ectosymbionts associated in Australia with crustacean hosts, particularly parastacid crayfish. For more than 100 years, spiny mountain crayfish (*Euastacus* spp.) have been recognised as important hosts for temnocephalans. This genus is endemic to eastern Australia and is distributed along the Great Dividing Ra. from Cooktown in North Queensland to the South Australia–Victoria border (Morgan, 1986, 1988, 1989, 1991, 1997). To date, 43 species of *Euastacus* have been described (Coughran, 2002).

The first temnocephalan recorded from *Euastacus* crayfish was a large worm with five tentacles and brown pigment, *Temnocephala fasciata* Haswell, 1888, from the external carapace of *Astacopsis serratus* (Shaw, 1794) (A name now known to encompass several species in the genus *Euastacus*). Haswell (1888) mentioned smaller white worms with six tentacles, which he believed to be immature *T. fasciata*. Subsequently, Haswell (1893) recognised the distinctiveness of these 6-tentacled worms and named them *Temnocephala comes*. Much later in a footnote, Haswell (1924) provided brief details of another 6-tentacled worm with brown pigment which he planned to describe formally, but never did. This incompletely described worm, *Temnocephala simulator* Haswell, 1924, and the earlier *Temnocephala comes* Haswell, 1893 remain the only named species of 6-tentacled worms from *Euastacus* hosts. Periera & Cuocolo (1941) later proposed *Temnohaswellia* to accommodate the 6-tentacled worms formerly in *Temnocephala*.

Although *Temnohaswellia* also occurs in New Zealand where a single species, *T. novaezealandiae* (Haswell, 1888), is associated with freshwater crayfish *Paranephrops* (see Fyfe, 1942), in Australia this genus is known only from *Euastacus*.

In Australia, two further species of *Temnohaswellia* were described by Cannon (1993) from single specimens collected from freshwater shrimp, *Caridina* sp. (*nilotica* ?) at Aplin Weir, Townsville, north Queensland: *Temnohaswellia pigna* Cannon, 1993 and *T. tetrica* Cannon, 1993. We now believe that the record from *Caridina* sp. and the subsequent wrong identification of the worms is because of an error in specimen labeling. The worms probably came from a species of *Euastacus* from NSW (probably *Euastacus suttoni* from Glen Innes) and should be referred to Haswell's species *Temnohaswellia comes* and *T. simulator* respectively. Evidence to support

this belief is presented in the remarks section of *Temnohaswellia comes* description in this paper.

Haswell (1924) also drew attention to a possible new species of 5 tentacled worms which he described as a variety of *Temnocephala fasciata* and for which he figured the cirrus. In fact several species of temnocephalan worms with 5 tentacles occur in Australia on freshwater crayfish, crabs and shrimps (Hickman, 1967; Cannon, 1993; Cannon & Sewell, 2001). Australian members of *Temnocephala* with 5 tentacles were transferred to *Temnosewellia* by Damborenea & Cannon (2001).

Although Cannon & Sewell (1994) predicted that the recorded temnocephalan fauna of *Euastacus* would increase with closer examination of the hosts, to date only two other temnocephalans have been described from spiny mountain crayfish, *viz. Heptacraspedella peratus* Cannon & Sewell, 1995, and *Gelasinella powellorum* Sewell & Cannon, 1998. Both belong to the subfamily Craspedellinae, members of which live on crayfish gills.

The current study of *Temnohaswellia* and *Temnosewellia* from *Euastacus* hosts in Australia greatly increases the number of species recognised from these crayfish and complements a wider study to examine the possible co-evolution of temnocephalans and their *Euastacus* hosts using morphology and DNA sequences.

MATERIALS AND METHODS

Euastacus crayfish were collected from freshwater habitats either by hand after turning rocks or by using baited collapsible minnow traps. Many field localities visited and sampled in 1990–1992 by LRGC and KBS as part of fieldwork described in Cannon & Sewell (1994) were revisited in 2002 to collect live *Euastacus* hosts and their temnocephalan associates for histology and DNA analysis.

Most collected crayfish hosts are registered in the Queensland Museum (QM) Crustacean collection. The museum registration numbers of these are provided here, along with the registration numbers of any hosts from other Australian museums from which temnocephalans were borrowed. Where a crayfish is not registered with a museum it is termed 'unregistered host' the record is followed, where known, by the name and institutional details of the person who identified the host.

Specimen data are listed in condensed format in the order: QM registration number; specimen/slide preparation details (in parentheses, with the number of slides in square brackets [ ]); host specific name; museum host registration number, or for unregistered hosts, the host identification authority and details (in square brackets [ ]); locality details as provided with host; date collected; collector(s); histological fixation/staining procedures.

In the Materials section, full registration details are provided only for each holotype specimen and for each new locality. Discrete blocks of registration data are separated by semicolons. Data for all subsequent specimens listed (including paratypes) in the Materials section data are condensed to reduce repetition of data that are often common to a range of specimens e.g. location, date and collectors. The museum host registration number or identification details, museum temnocephalan registration number, and specimen slide preparation details are always provided, followed only by those data which are different from that of the preceding registration. Specimens recorded in the Materials section, other than type material and material from the type locality, are grouped by crayfish host, then Australian state, with wholemounts listed first followed by cirrus preparations and then serial sections. We consider these abbreviated data valuable as they readily allow other workers access to information without the ongoing need to query collection databases.

The single specimen of *Temnohaswellia comes* (Haswell, 1893) from the Australian Museum, Sydney was examined. This slide-mounted specimen was labelled 'type' and we assume it is the holotype. Specimens of *Temnohaswellia novaezealandiae* (Haswell, 1888) were obtained from *Paranephrops zealandicus* collected by colleagues in New Zealand, fixed and sent to Australia. Types of this species were not available in any museum collection in Australia or New Zealand. Specimens in 70% ethanol identified by William A. Haswell as *Temnocephala fasciata* Haswell, 1888 from the Australian Museum, Sydney were examined. Types, labeled as such, were not found in any museum in Australia or New Zealand. For other early-described species without types designated by their authors, we have selected a neotype only if we believe there is potential for confusion in identification. Only *Temnohaswellia simulator* comes into this category.

Live temnocephalans were removed from the surface of the crayfish using a sharp wooden

point or fine forceps. Processing of crayfish and worms and descriptive terminology essentially follows the conventions established by Cannon & Sewell (1995) and updated by Sewell & Cannon (1998a) and Cannon & Sewell (2001). Refinement of the protocols associated with temnocephalan taxonomy has continued in the present study. We therefore present here a detailed account of all methods currently employed.

Cold 100% ethanol was recognised as a valuable routine fixative for temnocephalans for the following reasons: worms fixed in this way are usually extended in a life-like manner and thus ideal for preparation of wholemounts (WM); worms can be cleared and mounted unstained without the need for further dehydration; worm tissue remains useful for DNA analysis; and worms can be rehydrated in water and mounted in Faure's medium to allow examination of the sclerotised components. In previous taxonomic publications (see Cannon & Sewell, 1995, 2001; Damborenea & Cannon, 2001; Sewell & Cannon, 1998a, b) we termed the chloral hydrate-based mounting medium we used (distilled water 50ml; chloral hydrate 50g; glycerol 20ml and gum arabic 30g) as 'de Faure's mounting medium'. The term is renamed in the present paper as Faure's mounting medium in the light of information provided by Upton (1993) who stated that this recipe (which originally included a small quantity of cocaine) was first devised by Dr Giovani Faure (not 'de Faure') in 1910.

Unstained wholemounts we regard as generally more useful for routine specimen preparation than stained specimens as they allow better definition of the male and female reproductive hard parts, and thus confirmation of the species' identity. To mount specimens unstained, after fixation in Bouin's fixative, they were soaked in a solution of 70% alcohol saturated with lithium carbonate to remove picric acid.

The pattern of the epidermal mosaic is well established as a valuable taxonomic character to discriminate taxa at the level of order and family (Joffe & Cannon, 1998; Cannon & Joffe, 2001; Damborenea & Cannon, 2001), but thus far has been regarded as less useful at lower taxonomic levels e.g. genus and species. Our investigations of the pattern of the epidermal mosaic are limited to a single species of each genus namely: *Temnohaswellia comes* and *Temnosewellia cypellum* sp. nov. Nonetheless, the pattern of the epidermal mosaic is included here as a potentially valuable character at the genus level. Terms used for the syncytia follow Joffe & Cannon (1998) and Cannon & Sewell (2001).

To show the epidermal mosaic, live worms were fixed by flooding with a solution of 2% silver nitrate heated to about 60°C, washed in distilled water then exposed to either bright sunlight, or incident light from a 'Volpi' cold light source for 15 to 30 minutes, dehydrated in ethanol and mounted in Euparol.

Since our initial use of Faure's mounting medium to clear worms (Cannon & Sewell, 1995), our species descriptions have relied increasingly on the sclerotised cirrus (male reproductive hard parts) as a character to discriminate species. In the case of *Temnohaswellia*, the arrangement of the sclerotised components of the vagina are equally valuable. Faure's medium provides much clearer images of these sclerotised organs than are available from stained or unstained wholemounts mounted in Canada Balsam. Nevertheless, we now recognise the following limitations of the use of Faure's medium. 1) Most importantly, slides mounted in Faure's medium are only semi-permanent and variable in their longevity (Upton, 1993). To counter the potential deterioration through drying of specimens mounted in Faure's, we have ringed the specimens using clear lacquer around the edge of the coverslip. It has been brought to our attention by one of the reviewers of this manuscript, that the use of Lanoline-Colophonium resin to ring specimens mounted in Faure's may better preserve the preparations. 2) The width of cirri increases slightly over time (years), presumably as the specimen flattens under the weight of the coverslip. 3) In the case of large, pigmented worms it is necessary to dissect the worms and remove the cirrus to obtain a good view of the organ. Dissection can be made easier by fixing live worms at capture in a few drops of Faure's medium. They can be stored in this way for extended periods until the need to mount the cirrus: this has the advantage that the specimen becomes softened in the medium and can thus more easily be dissected to remove the cirrus. For optimal results, specimens should be placed in Faure's medium before fixation. Fixed specimens should be soaked in water at least overnight to soften tissue prior to mounting in Faure's medium or prior to dissection to remove the reproductive structures.

Our descriptions of the cirrus and vagina are based on light microscope (LM) examination conducted with the aid of Nomarski interference

contrast. These organs occur in the posterior portion of the worms. Consequently we typically retained this part for morphological identification (i.e. after mounting in Faure's medium) and subsequent registration of the posterior end as a voucher specimen in a museum collection, while allowing the anterior end to be available for DNA sequence studies.

Images were captured digitally using Aresoft Zipshot and edited and assembled into plates using Adobe Photoshop, diagrams were prepared using Adobe Illustrator.

TERMINOLOGY AND MEASUREMENTS

Body pigment, although rare in *Temnohaswellia* spp., is commonly present in *Temnosewellia* spp. Where present, it is comprised of fine brown particles forming a complex, ramifying dorsal network that penetrates the parenchyma and becomes less dense and regular ventrally. The general pattern of the pigment can be seen in wholemount specimens in Canada balsam, but is particularly clear in specimens mounted in Faure's medium. The pattern described for *Temnosewellia fasciata* by Haswell (1893) is typical of adults of most pigmented *Temnosewellia* species from *Euastacus* crayfish. Dorsally the pigment is continuous and, at least in larger worms, adopts a close woven appearance that usually resembles a network or cloth (Figs 19D, E; 23E, G; 33A). The body pigment is often concentrated around the eye region, including between the eyes, and extends to the tentacles, but is absent from the major reproductive, excretory and digestive organs (e.g. testes, excretory ampullae, gut), and the nervous system (e.g. nerve cords). This absence results in open spaces in the pigment that outline these organs and the nerve plexus (Fig. 27A). The pigment is generally little developed on the ventral body surface and on the dorsal surface of the sucker. The density of body pigment was, however, observed to vary within and between species.

Some species completely lack body pigment, even as large adult specimens. These worms appear white except for discrete brown to dark brown eyes and a dark gut. In some species, though juvenile worms may have almost no body pigment, as the worms increase in size (= age) the density of pigment increases such that large worms have the typical dense woven pattern. In other species, juvenile worms may have well developed pigment, although it is always less dense than in large adults.

Our descriptions of body pigment focus on the dorsal most body pigment of adult worms and we use three terms to describe the pigment pattern: 'lacking', 'typical' and 'punctate'. Worms that have no pigment granules in the dorsal body or have pigment granules restricted to a small concentration around or between the eyes are classified as 'lacking' body pigment. We term as 'typical' the pattern of dense, woven dorsal body pigment such as that described for *Temnosewellia fasciata* by Haswell (1893). We term as 'punctate' dorsal body pigment that has clumped regions of denser pigment set within the woven network (Figs 23F; 45A).

Cannon & Sewell (1995) provided measurements of selected internal structures of only the taxonomic type series, indicating that such measurements are valuable only as guide to the overall size and shape of the worms and their organs. Here, we extend this assertion and exclude measurements of some internal structures (i.e. testes, excretory ampullae, ovary) provided in previous publications (Cannon, 1993; Cannon & Sewell, 1995, 2001; Sewell & Cannon, 1998a).

Our taxonomic descriptions again focus largely on the sclerotised reproductive structures as providing characters for discriminating species. In the current study we were able to obtain sufficient material for most species to allow high resolution LM examination of the sclerotised components of the male and female reproductive organs cleared in Faure's medium. Nevertheless, resolution of detail is sometimes difficult and we choose to remain cautious in our counts, indicated by '?', of jumbled overlapping structures. Given our continued and increasing reliance on these structures as characters to discriminate species, it is timely to reiterate and update some of the terminology used (see Fig. 1A, B).

After Cannon & Sewell (1995), we define the cirrus as the entire sclerotised male copulatory organ comprised of an 'introvert' (flexible distal eversible region armed with spines) and 'shaft' (rigid, tubular region tapering distally). Shaft length was measured from the proximal rim to the introvert base along the outside of the shaft wall but inside the introvert swelling. Although the cirrus generally appears to be more or less curved, the degree of curvature of the shaft is in our opinion not a reliable taxonomic character,

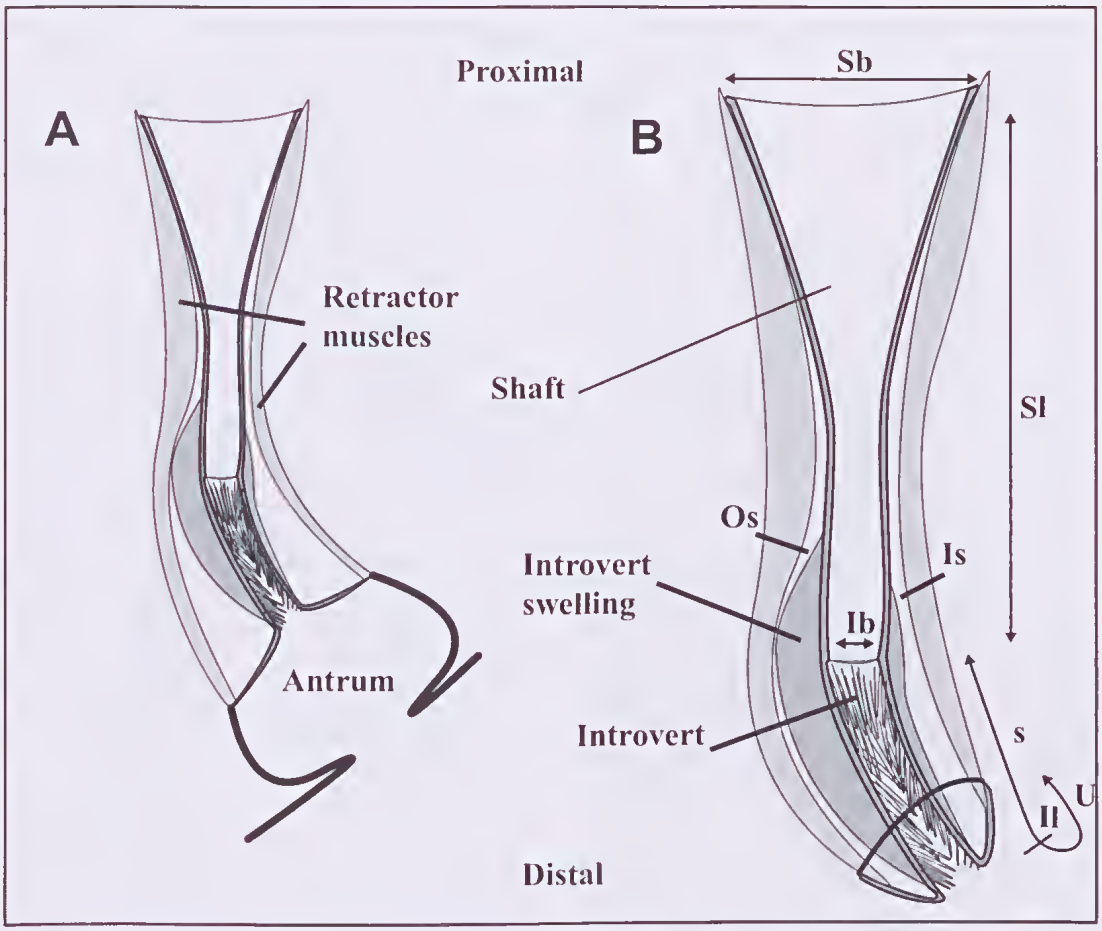


FIG. 1. Diagram of the temnocephalan cirrus typical for *Temnohaswellia* in sagittal view. A, orientation and relationships of the shaft, retractor muscles, eversible spined introvert (with unspined region), and the opening of the antrum; B, measured regions of the cirrus used for species descriptions. Sl, shaft length; Sb, shaft base width at the proximal end; Il, introvert length (of spined region(s) on the introvert longer [= outer] side); Ib, introvert base width at the proximal end; Is, Introvert swelling extending proximally past the introvert base on the the inner side; Os, introvert swelling extending proximally past the introvert base on the outer side of the cirrus; U, unspined distal region.

often being affected by fixation and by mounting in Canada balsam.

The introvert extends from the distal insertion of the introvert eversion muscle to the proximal junction with the shaft, i.e. the introvert base (Fig. 1A, B). The introvert is the portion of the cirrus first formed in juveniles, and its dimensions, unlike those of the cirrus shaft, remain nearly constant as worms age (unpublished observations). In most temnocephalans the introvert bears spines throughout its length, but in many Australian species of *Temnohaswellia* there is a distinct unspined zone distally that is well sclerotised (labeled 'U' in Fig. 1B) and frequently appears as a collar folded back over the spiny region. It is unclear from light microscopy whether this zone comprises a terminal part of the cirrus or is part of the antrum. In other genera this zone is less well developed and may be difficult to resolve. We have termed the zone the 'unspined distal region' (Fig. 1A-B). The unspined distal region is often very difficult to observe in specimens not cleared in Faure's medium. Sometimes it has prominent longitudinal folds similar in appearance to those figured by Haswell (1888: plate XXII, fig. 8) for *Temnomonticellia quadricornis* (Haswell, 1888) and often it has thickened walls distally. The presence and/or dimensions of this character

can be difficult to determine if specimens are not well cleared in Faure's medium, or when the cirrus is very small. Consequently, we have listed the measurements of the spined region of the introvert and the unspined distal region separately in species descriptions.

The introvert swelling is the optically distinct layer surrounding the inner introvert wall from which the spines project inward and distally when the cirrus is not everted (Cannon & Sewell, 1995). The introvert swelling is a clearly recognisable hyaline structure but we are not able to describe it in detail histologically or to confirm its exact function. The introvert swelling varies in thickness along the length and around the circumference of the introvert, and extends proximally past the introvert base to the distal region of the shaft (Fig. 1A–B). The swelling can be classifed as 'even', 'uneven' or 'very uneven' in the relative thickness of the longer and shorter sides of the introvert (Fig. 2). Where the swelling is not even, it is invariably thicker on the longer side of the introvert (Fig. 1A–B). The relative shape and size of the introvert swelling are useful taxonomic characters with the following limitations. The dimensions of the introvert swelling, unlike the other dimensions of the introvert, appear to increase somewhat as worms increase in size (= age). Moreover, in some specimens, the swelling is difficult to resolve, usually either because it has completely cleared as a result of an extended period in Faure's medium or because it is very narrow.

Descriptions of the cirrus and the introvert refer to the inverted/relaxed state of the structure (Figs 1A–B, 2). Two main cirrus eversion muscle bundles attach to the distal region of the introvert dorsally and ventrally. In specimens mounted in Faure's medium, the presence of these muscle bundles ensures that the cirrus rolls, under the coverslip pressure, to present a longer and shorter introvert side when the distal opening is oblique.

The shape of the shaft may be described as a 'funnel', 'goblet' or 'cone' (Fig. 2). Funnel or goblet-shaped shafts have a wide proximal region, which tapers rapidly to form a narrow tubular distal region (Fig. 2).

We recognise the general shape of the spined region when inverted as (i) like a 'cylinder', i.e. a continuation of the introvert margins, without inflation, of the line of the shaft, (ii) a 'cone', i.e. with the distal opening wider than the base, (iii) a 'scoop', i.e. with the lateral margins inflated, but with a distal opening not greatly larger than the base, and (iv) a 'goblet', i.e. with inflated lateral margins and an opening greatly wider than the base (Fig. 2). We also recognise the distal opening of the introvert spined region may be at right angles to the long axis of the shaft, i.e. 'transverse', or it may be 'oblique' or even 'very oblique' (Fig. 2).

Descriptions of the introvert generally exclude fine details of the spines. In general the spines are longest on the longer side of the introvert and are shorter distally. Detailed analysis of the spination at the light microscope level requires examination of fully everted cirri, a situation which, in our experience, occurs relatively rarely in fixed specimens. The introvert spines are attached to ridges that run parallel to the long axis of the introvert. However, in some species the ridges spiral, so that spines on adjoining parallel ridges line up optically in rows that appear diagonal to the long axis of the inverted introvert. Measurements of the cirrus are recorded from selected cirrus preparations from the type host and locality cleared in Faure's medium that were the best representatives of those available i.e. undamaged specimens lying flat.

Although the cirrus is a principal focus for the recognition of temnocephalan species we have found that in *Temnohaswellia* the sclerotised nature of the vagina is a most useful character (see Fig. 3A–B). After Cannon (1986), we term a vagina the entire region of the female tract that extends inwards from the common genital opening and ends distal to the entrance of the oviducts. The vagina (Fig. 3A–B) consists of: 1) the 'distal vagina', a broad distal cavity with muscular walls (delineated distally by a variably developed sphincter); and 2) the 'proximal vagina', a narrower proximal cavity with thinner muscular walls, a thin inner surface with a less regular shape and clearly able to expand. The inner surface of the entire vagina, particularly in species of *Temnohaswellia*, is folded into obvious longitudinal and circumferential ridges, with a pattern similar to the ribbed cuff of a knitted sock. This surface may be sclerotised to variable degrees. The ridges are delineated into 'columns' by the pattern of large longitudinal muscle bundles, and 'rows' demarked by smaller circumferential muscles. Here, we further divide the distal vagina into: 1) an 'outer region' adjacent to the opening to the atrium that is often thickly sclerotised and formed into teeth (Fig. 3B); and 2) an 'inner region' which

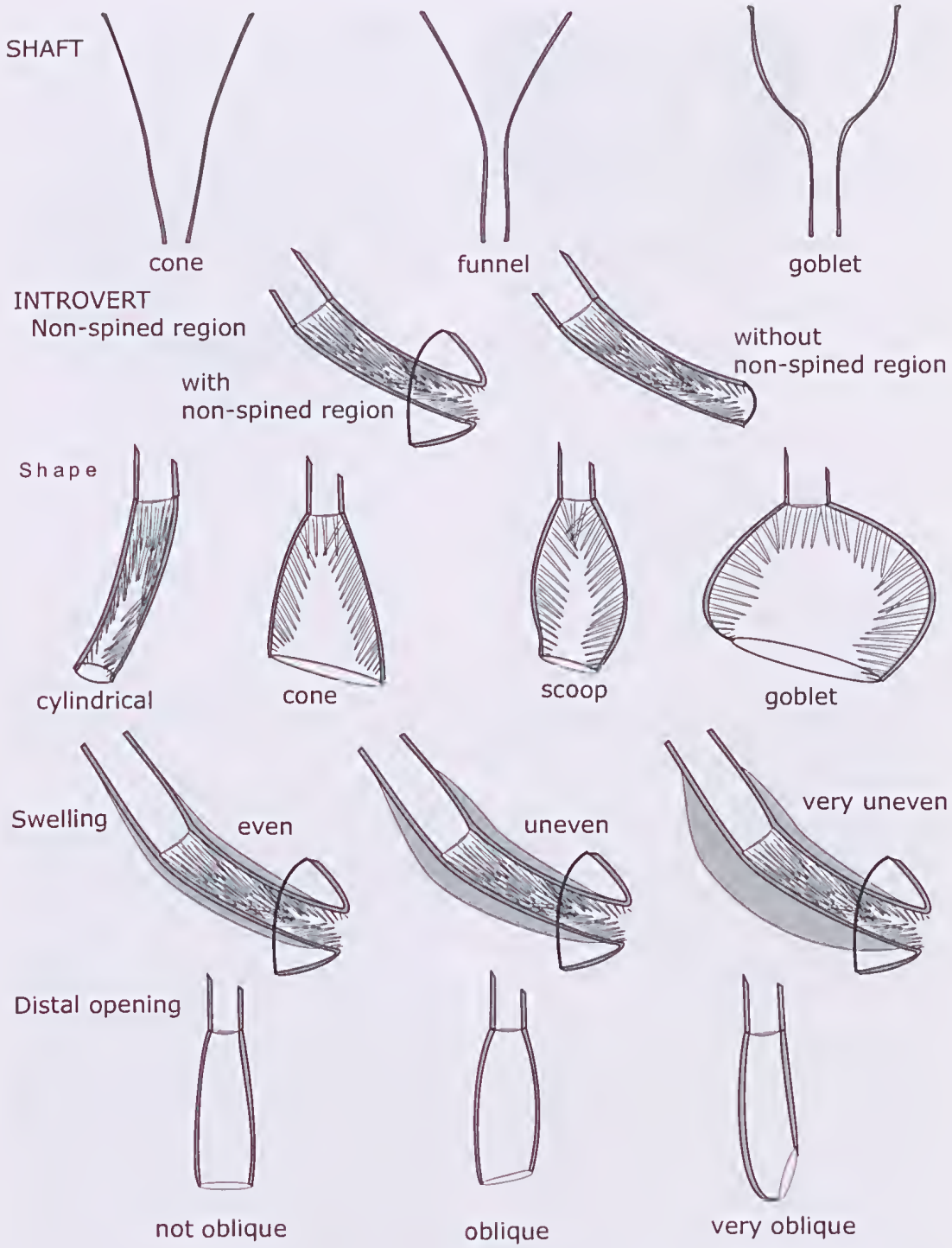


FIG. 2. Diagrams showing the terminology applied to the shaft (top row) and introvert (remaining rows) of the temnocephalan cirrus. See text for a full description.

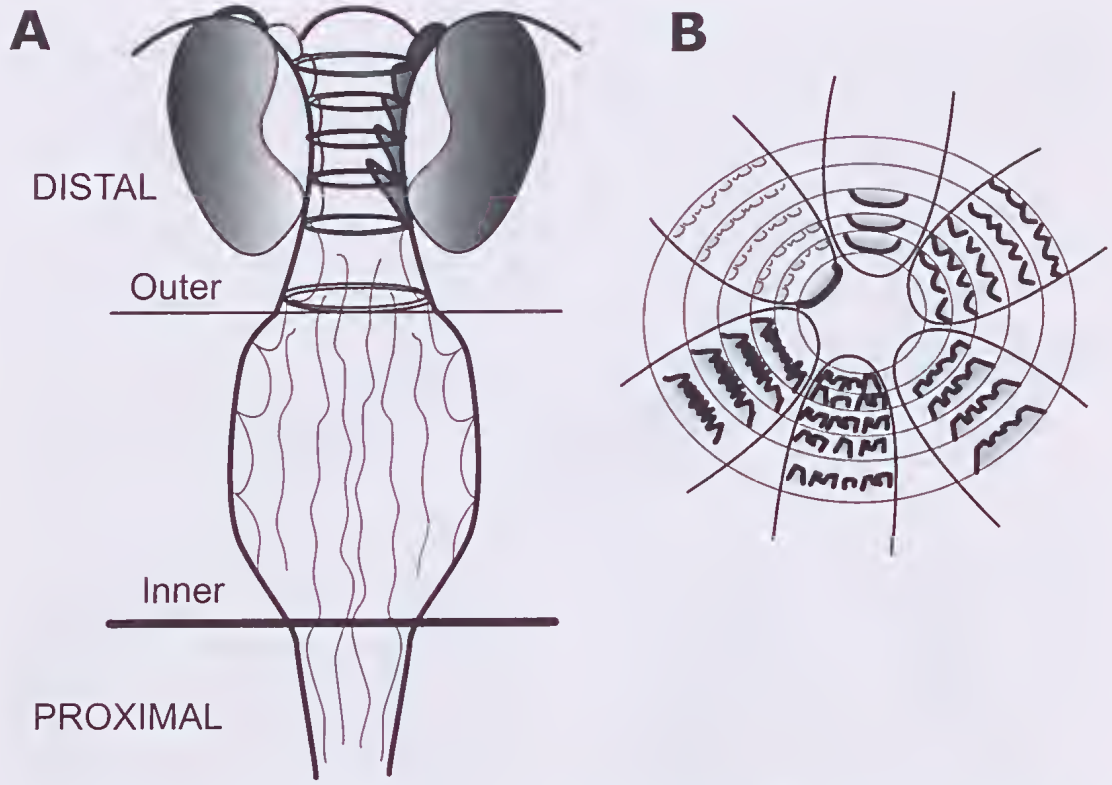


FIG. 3. Diagrams of the temnocephalan vagina. The arrangement figured is more typical of *Temnohaswellia*. A, vagina (sagittal) showing distal muscular sphincter, middle chamber with expandable walls and inner (proximal) canal. B, diagram (as if looking out towards genital pore) of the variety of sclerotised 'teeth' which can be found adorning the vaginal walls.

is frequently less sclerotised and more sac-like (expansive). Our descriptions of the vagina of *Temnohaswellia* focus largely on the sclerotised surface features of the outer region of the distal vagina. Descriptions of the vagina are derived mostly from Faure's preparations of the cirrus and surrounding areas, but in some cases also from histological sections.

All measurements were made in microns (μm) with the aid of a drawing tube. The sequence adopted for presentation of general body measurements is: 'B', total length of worm to tip of tentacles × width at greatest dimension; 'LE', length from posterior of worm to eyes; 'PH', pharynx length × width; 'SD', sucker diameter; 'PD', sucker pedunele diameter.

The sequence for the the cirrus measurements (see Fig. 1A–B) is: 'S', shaft length [Sl] X shaft base diameter [Sb]; 'I', Introvert length of spined region [Il] X introvert base width [Ib]; 'U', length of unspined introvert region (if present); 'IS', length of introvert swelling proximal to the introvert base on introvert outer side [Os] × length of introvert swelling extending proximal to introvert base on introvert inner side [Is].

The following abbreviations are also used: ACT, Australian Capital Territory; AD, adhesive disk syncytium, Alc, ethanol; AM, Australian Museum, Sydney; Bouin, Bouin's fixative; BS, body syncytium; ca, circa; CALC, locality co-ordinates calculated from locality description provided; Ck, Creek; CP, cirrus preparation; Fau, Faure's mounting medium; E, east; Form, 10% formalin buffered to pH 7.0 with phosphate; Form-Acetic, Acetic-Formalin-Alcohol (AFA); Carn, Carnoy's fixative; FP; Forest Park; FR Forest Reserve; g, gonopore; H, Holotype; H&E, haematoxylin and eosin stain, HF, hot 10% formalin; HW, hot water, Hx, Mayer's or Harris's haematoxylin stain; LS, longitudinal sections; m, mouth; MB, melanin bleached; MP, epidermal mosaic preparation stained

with silver nitrate and mounted in Euparol; N, neotype; na, not available; NMV, Museum of Victoria, Melbourne; NP, National Park; np, nephridiopore; NR, Nature Reserve; nr, near; NSW, New South Wales; NZ, New Zealand; P, paratype; PP, pigment preparation; Qld, Queensland; PS, peduncular syncytium; PTS, post-tentacular syncytium; QM, Queensland Museum; R., River; Ra., Range; S, South, SA, South Australia; SF, State Forest; trib., tributary; TS, tentacular syncytium; Un, unstained; VIC, Victoria; WNW, west north west; WM, wholemount [Canada balsam].

TAXONOMY

Order TEMNOCEPHALIDA

Family TEMNOCEPHALIDAE Monticelli, 1899

Subfamily TEMNOCEPHALINAE

Temnohaswellia Pereira & Cuocolo, 1941

Temnohaswellia Pereira & Cuocolo, 1941: 103.

TYPE SPECIES. *Temnocephala novaezealandiae* Haswell, 1888, by original designation of Pereira & Cuocolo, 1941. Gender feminine. Host: *Paranephrops zealandicus* (White, 1847) [senior synonym of *Paranephrops setosus* Hutton, 1873 and *P. neozelanicus* Chilton, 1889].

DIAGNOSIS. Temnocephalinae generally less than 3mm long, six anterior tentacles and posterior pedunculate adhesive disc present; conspicuous papillate ridges or imbricating scales absent from tentacles or dorsal body; single dorsal pair of brown to dark brown pigmented eyes at base of tentacles; brown to dark-brown body pigment (melanin?) usually absent or restricted to region around or between eyes. Gut appears dark. Sclerotised distal vaginal cavity folded to form prominent papillae or 'teeth' distally, and longitudinal ridges and folds proximally. Testes two pairs postero-lateral to gut; vasa deferentia enter seminal vesicle separately; ejaculatory sac usually semi-discrete (with slightly-narrowed neck). (All species other than *T. novaezealandiae* restricted to Australia and only on *Euastacus* spp.).

Epidermal Mosaic (based on *Temnohaswellia comes* (Haswell, 1893)). Epidermis composed of 5 syncytia: 1, tentacular; 2, single, characteristically saddle-shaped, post-tentacular plate; 3, body; 4, peduncular; and 5, adhesive disc (Fig. 9). Post-tentacular syncytium contains the nephridiopores dorsally. Shallow groove marks border between dorsal and ventral surfaces along lateral margins of body and peduncular syncytia.

INCLUDED SPECIES

Temnohaswellia alpina sp. nov.
Temnohaswellia breviumbella sp. nov.
Temnohaswellia caprieornia sp. nov.
Temnohaswellia comes (Haswell, 1893)
= *T. pigua* Cannon, 1993
Temnohaswellia cornu sp. nov.
Temnohaswellia crotalum sp. nov.
Temnohaswellia munifica sp. nov.
Temnohaswellia novaezealandiae (Haswell, 1888)
Temnohaswellia pearsoni sp. nov.
Temnohaswellia simulator (Haswell, 1924)
= *T. tetrica* Cannon, 1993
Temnohaswellia subulata sp. nov.
Temnohaswellia umbella sp. nov.
Temnohaswellia verruca sp. nov.
Temnohaswellia sp.

KEY TO SPECIES OF *TEMNOHASWELLIA*

1. Body pigment present in large specimens, or a concentration of pigment around the eye region 2
   Pigment lacking except for a thin tracery between the eyes 3
2. Body pigment concentrated in the eye region; outer vagina with a few teeth .. *T. simulator* (Haswell, 1924)
   Body pigment not concentrated in the eye region; outer vagina with very numerous large teeth ..... *T. novaezealandiae* (Haswell, 1888)
3. Teeth in the outer vagina 6
   No teeth in outer vagina 4
4. About 10 large spines on the base of the introvert ..... *T. comes* (Haswell, 1893)
   No large spines on the base of the introvert 5
5. Cirrus shaft gracile and gently tapered, with long, narrow cylidrical introvert about 130µm long ..... *T. subulata* sp. nov.
   Cirrus shaft not gracile and gently tapered, with short, cylindrical introvert about 55µm long.... *T. cornu* sp. nov.
6. Eyes present 7
   Eyes absent; outer vagina with about 6 rows and columns of rounded teeth ..... *T. pearsoni* sp. nov.
7. Outer vagina with block-like teeth arranged in very obvious columns and rows, larger proximally .. *T. crotalum* sp nov.
   Outer vagina with teeth that are not block-shaped ... 8
8. Rows and columns of teeth in the outer vagina that resemble combs 9
   Rows and columns of teeth in the outer vagina do not resemble combs 10
9. Blunt, comb-like teeth in the outer vagina, larger

proximally: cirrus with long unspined distal region with prominent longitudinal folds about twice as long as the spined region ..... *T. umbella* sp. nov.

Sharp, comb-like teeth in the outer vagina, smaller proximally; cirrus with long unspined distal region with prominent longitudinal folds about same length as the spined region ..... *T. breviumbella* sp. nov.

10. A single row of cusp-like teeth that ring the distal opening of the outer vagina, otherwise lacking teeth 11

Lacking a single row of cusp-like teeth that ring the distal opening of the outer vagina; with rows and columns of teeth 12

11. About 6 cusp-like teeth present ..... *T. verruca* sp. nov.

About 8 cusp-like teeth present ..... *T. alpina* sp. nov.

12. Outer vagina with about 4 rows of large, teeth; cirrus introvert large ..... *T. munifica* sp. nov.

Outer vagina with about 2 rows of teeth ..... *T. capricornia* sp. nov.

Temnohaswellia novaezealandiae (Haswell, 1888) (Fig. 4A–D)

Temnocephala novaezealandiae Haswell, 1888: 284, pl. 22, figs 10, 19.

Temnohaswellia novaezealandiae: Pereira & Cuocolo, 1941: 103.

ETYMOLOGY. Clearly for New Zealand, where both worm and host are found.

MATERIAL. QMG211229–211233 (WM) from *Paranephrops zealandicus* [unreg. host], Orokunui Stream, Blueskin Bay, Dunedin (45°45'S 170°35'E), Jul. 1992, T. Dodgshun, HW/70% alc/Hx; [QMW26676], QMG221175–221179 (WM), McRaes Ck, Otago, New Zealand (45°48.0'S 170°25.1'E), 5.10.1996, K. Garrett, 100% alc/Un; QMG221167–221168, 221171–221174 (CP) 100% alc/Fau; QMG221169–221170 (CP) 100% alc/Fau/Alcian Blue; QMG221180–221184 (CP), 100% alc/Fau. QMG221191–221194 (CP) from *Paranephrops zealandicus* [unreg. host], Taieri R. trib., Otago, S Island, New Zealand, ca Nov. 2002, J. Hollows, 100% alc/Fau.

DESCRIPTION. *Temnohaswellia novaezealandiae* was described by Haswell (1888) and revised by Haswell (1893, 1924), Merton (1914) and Fyfe (1942). The description is updated here from fixed specimens with reference to these previous works, particularly that of Fyfe (1942).

General Anatomy. Characteristics of genus, but lacking pigment in young worms (except for brown intestine), with light brown pigment distributed in dorsal body and not concentrated around the eye region. Selected body measurements of specimens from *Paranephrops zealandicus* are: QMG221175: B(3019 × 1938), LE(1999), PH(545 × 683), SD(797), PD(480); QMG221176: B(3550 × 2081), LE(2387), PH(691 × 715), SD(854), PD(537); QMG221177: B(2203 × 1673), LE(1754), PH(520 × 528), SD(423), PD(650); QMG221178: B(1897 × 1714), LE(1469), PH(419 × 593), SD(602), PD(366); QMG221179: B(3774 × 1489), LE(2509), PH(748 × 650), SD(268), PD(268).

Reproductive System. Female. Vagina: Outer region with teeth, arranged in very numerous columns and rows of large, wide based, triangular teeth [as figured by Haswell (1893: plate XIV, fig 3); Fyfe (1942: plate 22)] with often rounded tip, smallest distally and proximally. Distal vagina very thickly muscled.

Male. Cirrus: General form as figured by Haswell (1893: plate XIII, fig. 17). Shaft cone-shaped. Introvert essentially as figured by Haswell (1893: plate XIII, fig. 18), cone to scoop-shaped; distal opening slightly oblique to oblique [as figured by Haswell (1893: plate XIII, fig. 18)]. Unspined distal region absent, but with distinct thickened rim at point of insertion of introvert eversion muscle. Swelling even [as figured by Haswell (1893 : plate XIII, fig. 18)], extends proximally well past introvert base on both sides, slightly farther on longer side. Distal spines project conspicuously past distal tip of fully inverted introvert [as figured by Haswell (1893: plate XIII, fig. 18); Fyfe, (1942: plate 22)]. Selected cirrus measurements of specimens from *Paranephrops zealandicus* are: QMG221169: S(602 × 181), I(116 × 59), IS(244 × 197); QMG221170: S(411 × 167), I(114 × 59), IS(na × 71); QMG221171: S(392 × 122), I(130 × 55), IS(203 × na).QMG221180: S(367 × 93), I(100 × 51), IS(181 × 122); QMG221181: S(533 × 183), I(102 × 47), IS(167 × 163); QMG221182: S(413 × 157), I(102 × 51), IS(152 × 132); QMG221183: S(551 × 128), I(108 × 51), IS(254 × 234).

HOSTS. *Paranephrops* spp.

DISTRIBUTION. New Zealand: from streams of the North and South Islands.

REMARKS. Haswell (1888) listed *Temnohaswellia novaezealandiae* as a new species but provided an incomplete description based only on fixed specimens. Haswell (1893, 1924) and Merton (1914) subsequently updated the original description and Fyfe (1942) provided a comprehensive account of the anatomy and systematics of the species. More recently, considerable work has been done on the ultrastucture of the species (see for example, Williams (1975, 1982, 1985 and references therein).

Type specimens of *Temnohaswellia novaezealandiae* were not found by officers at any of the following institutions deemed to be likely

FIG. 4. *Temnohaswellia novaezealandiae* A–C, Nomarski interferenee eontrast photomierographs of Faure's preparations. A, QMG221182, whole cirrus. Seale = 250μm; B, QMG221182, vagina, scale = 250μm. C, QMG221182, introvert, seale = 100μm. D, QMG221175, wholemounted speeimen showing light brown body pigment, scale = 1mm.

repositories for material examined by Haswell: The Otago Museum, Dunedin, NZ; The Cantebury Museum, Christchurch, NZ; The Auekland Museum, Auckland, NZ; The Museum of Wellington City & Sea, Wellington, NZ; and The Australian Museum, Sydney. There is, however, little doubt that the worms redescribed here are specimens of *Temnohaswellia novaezealandiae* whieh remains the only speeies of the genus known from New Zealand. We obtained speeimens from the host *Paranephrops zealandicus*, which was the host species from whieh Fyfe (1942) obtained living and preserved speeimens.

The worms are larger than all the Australian species examined in the present study.

Body pigment was observed to oeeur only in large specimens: it is comprised of fine, light brown granules with an uneven, slightly clumped distribution. Fyfe (1942), who observed live worms, deseribed the body pigment as greenish-grey or brown. The eyes of *Temnohaswellia novaezealandiae* are discrete and comprised of granules of a dark brown pigment. The eyes laek a coneentration of body pigment around them. In other species of *Temnohaswellia* with body pigment, the pigment is most concentrated around the eye region and sometimes closely assoeiated with the eyes, often in thick traets.

Haswell (1893: plate XIII, figs 17–18) drew the eirrus of *Temnohaswellia novaezealandiae* as long slender and eurved while Fyfe (1942) deseribed the organ as L-shaped and figured it so (Fyfe, 1942: plate 22). We do not consider the curvature of the cirrus as a very reliable taxonomic character, particularly in species that have a long cirrus shaft. In sueh species, the curvature varies between individuals from the same locality, ranging from nearly straight to considerably eurved. The curvature appears to be influeneed by the size of the organ and by fixation, and is frequently more pronounced in wholemounted speeimens where muscle contraction may influence the final shape.

The rows and columns of large teeth in the outer vagina of this speeies are much more numerous and extensive than those observed for any Australian species. Consequently, for *Temnohaswellia novaezealandiae*, the exact number could not be determined even from specimens mounted in Faure's medium. The shape of the teeth is somewhat variable within and between individuals and is apparently influeneed by the extent to which the rows are eompressed in the speeimen being examined. In some wholemounted speeimens and speeimens mounted in Faure's medium they appear almost as papillate crenulations (e.g. Fig. 4B) whereas in others they can appear more triangular as figured by Haswell (1924: plate LV, fig. 11), or even as rectangular with a triangular tip such as figured by Haswell (1888: plate XXII, fig. 19) and Fyfe (1942: plate 22). In this speeies the teeth are largest eentrally and smaller both proximally and distally, suggesting they may be added with growth (= age).

Temnohaswellia alpina sp. nov.
(Fig. 5A–D)

ETYMOLOGY. Latin *alpinus* = of the high mountains; referring to the Australian Southern Alps where the speeies occurs.

MATERIAL. HOLOTYPE: QMG220149 (WM), from *Euastacus rieki* [QMW26644], Wragges Ck on Kosciusko Rd 5km NE Perisher Valley, Kosciusko (36°22.9'S 148°27.4'E), 18.03.2002, K.B. Sewell, 70% alc/Un. PARATYPES: QMG220150 (WM), 70% alc/Un; [QMW26645], QMG220151 (WM), 14.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26644] QMG220152 (WM), 18.03.2002, K.B. Sewell, 70% alc/Un; [QMW26645], QMG220153 (WM), 14.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26644], QMG220154–220156 (CP), 18.03.2002, K.B. Sewell, 100% alc/Fau. OTHER MATERIAL. From *Euastacus* sp. NSW: [unreg. host] AMW28691–28692 (WM), Blue Pools, N of Tantangara Dam, Snowy Mts (35°45'S 148°39'E), 23.02.1969, J. Beeman, unknown fixation/Hx; AMW28693–28694 (LS[2.2]), unknown fixation/MB/H&E.

DESCRIPTION. Characteristics of genus but lacking body pigment exeept for thinly seattered pigment between the eyes. Seleeted body measurements of type speeimens from *Euastacus rieki* are: QMG220149: (H): B(1929 × 934), LE(1408), PH(497 × 386), SD(386), PD(223); QMG220150: (P): B(1236 × 707), LE(894), PH(236 × 293), SD(317), PD(179); QMG220151: (P): B(1057 × 455), LE(683), PH(187 × 293), SD(203), PD(89).

Reproductive System. Female. Vagina: Outer region with single row of about 8 cusp-like teeth.

Male. Cirrus: Shaft eone-shaped. Introvert cylinder-shaped; distal opening oblique. Unspined distal region about one fifth length of introvert longer side. Swelling uneven, asymmetrieal, wider on longer side, extending proximally slightly past introvert base on longer side and just past introvert base on shorter side. Selected cirrus measurements of

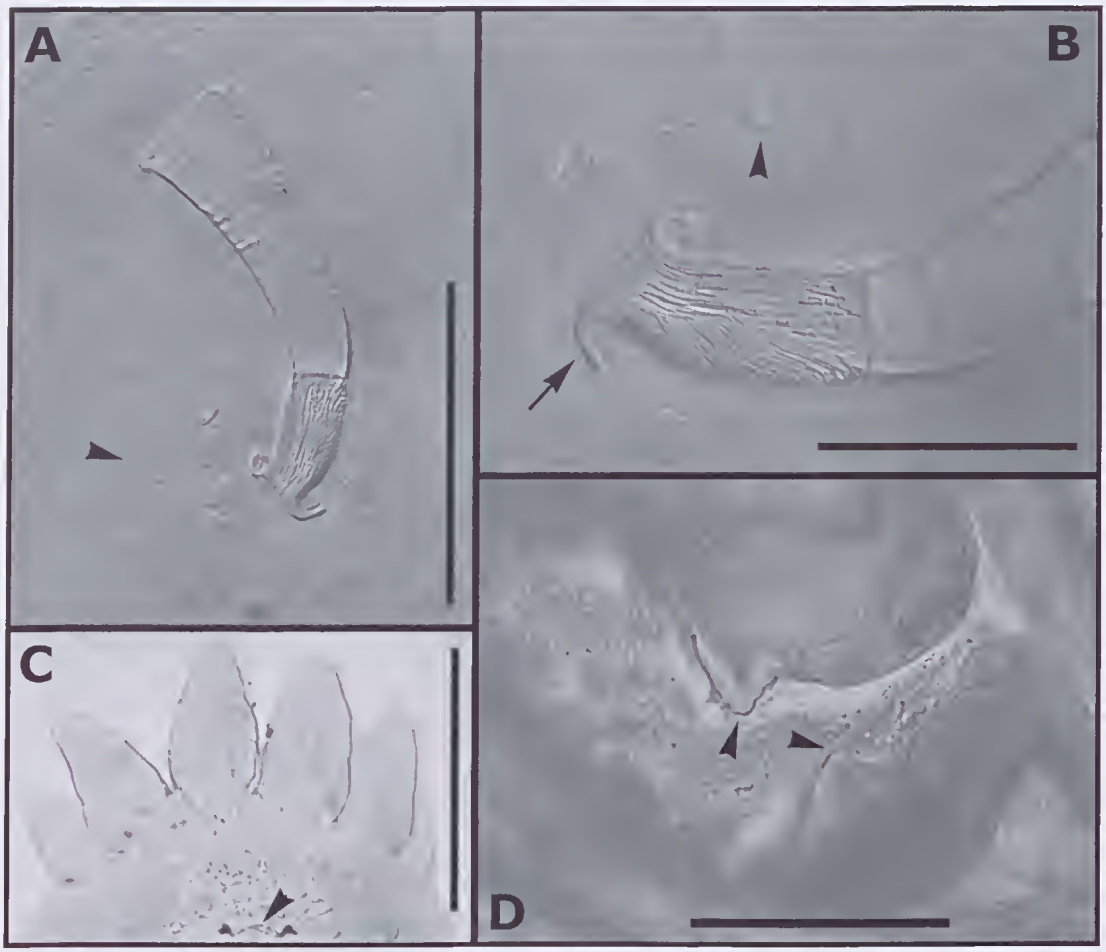


FIG. 5. *Temnohaswellia alpina* sp. nov. A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220156, whole cirrus and vagina (arrowhead), scale = 250μm; B, QMG220156, introvert with short unspined distal region (arrow) and vagina with cusp-like teeth (arrowhead) in the outer region of the distal vagina, scale = 100μm; C, QMG220149, anterior end of worm showing thin scatter of pigment between eyes (arrowhead), scale = 500μm; D, AMW28693, longitudinal section through vagina showing cusp-like teeth in the outer region of the distal vagina (arrowheads), scale = 50μm.

specimens from *Euastacus rieki* from the type locality are: QMG220149 [WM]: S(89 × 47), I(104 × 37), U(22), IS(na × na); QMG220154 [juvenile]: S(14 × 41), I(108 × 41), U(22), IS (na × na); QMG220155 [juvenile]: S(0 × na), I(102 × 37), U(20), IS(na × na); QMG220156: S(264 × 91), I(114 × 42),U(22), IS(60? × 4).

HOSTS. *Euastacus rieki*, *Euastacus* sp.

DISTRIBUTION. South-eastern NSW — from the Australian Alps region: Mt Kosciusko NP at Wragges Ck; and N of Tantangara Dam at Blue Pools.

REMARKS. The worms are morphologically close to *Temnohaswellia simulator*, but in *T. alpina* sp. nov. the outer vagina lacks numerous rows and columns of teeth, the cirrus introvert is longer, and the worms have no body pigment other than that between the eyes.

Temnohaswellia breviumbella sp. nov. (Fig. 6A–B)

ETYMOLOGY. From Latin *brevis* = short and *umbella* = parasol; a reference to the unspined distal region of the introvert that resembles a short folded parasol or umbrella.

MATERIAL. HOLOTYPE: QMG220054 (CP), from *Euastacus bidawalus* [QMW26588], Dingo Ck, crossing on Euchre Valley Drive, Lind NP, VIC (37°34.7'S

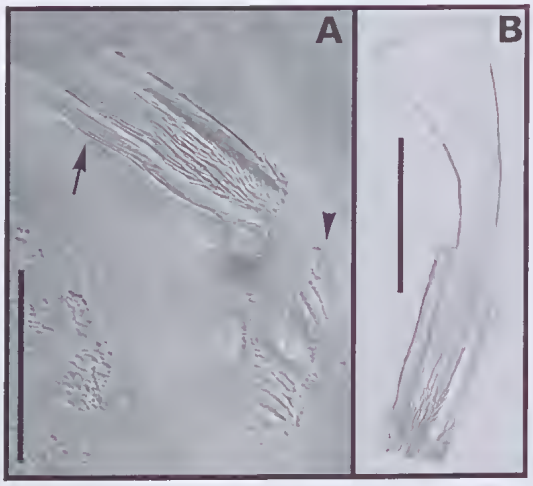


FIG. 6. *Temnohoswellia breviumbella* sp. nov. A, B. Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220054. Introvert with long unspined distal region (arrow) and vagina showing rows of comb-like teeth in the distal region (arrowhead). Scale = 100µm. B, QMG220054. Whole cirrus (stitched image). Scale = 100µm.

148°58.2'E), 20.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Fau. PARATYPE: QMG220055 (CP) 100% alc/Fau. OTHER MATERIAL FROM TYPE LOCALITY: [QMW27482], QMG221195, (CP), 5.01.2004, D. Blair, R.D. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Fau.

DESCRIPTION. Characteristics of genus but lacking body pigment except for eyes and occasionally thinly scattered pigment between them. Selected body measurements of type specimens from *Euastacus bidawalus* are: QMG220054 (H): B(1612 × 836), LE(1102), PH(306 × 367), SD(286), PD(163); QMG220055 (P): B(1326 × 836), LE(796), PH(245 × 306), SD(306), PD(163).

Reproductive system. Female. Vagina: Outer region with single row of cusp-like teeth distally (6?), proximally with teeth arranged in 6(?) columns and 8(?) rows of comb-like teeth increasingly smaller proximally.

Male. Cirrus: Shaft cone-shaped. Introvert cylinder-shaped; distal opening not obviously oblique. Unspined distal region long, thin, about length of introvert longer side, with prominent folds oriented parallel to long axis of the introvert. Swelling even, extending proximally just past introvert base on both sides(?). Selected cirrus measurements of type specimens from *Euastacus bidawalus* are: QMG220054: S(215 × 81), I(114 × 26), U(118), IS, (na × na); QMG220055: S(234 × 67), I(112 × 26), U(122), IS, (na × na).

HOST. *Euastacus bidawalus*.

DISTRIBUTION. South-eastern VIC — from the east Gippsland region: Lind, NP at Dingo Ck.

REMARKS. Only two Faure's mounted specimens are available but the species is clearly distinct. It most closely resembles *Temnohaswellia umbella* sp. nov. in the form of the vagina and cirrus. The introvert, however, is clearly shorter, particularly the unspined distal region of the introvert which is only half the length of that of *Temnohaswellia umbella* sp. nov. The cusps that ring the vaginal opening are particularly prominent. The exact dimensions of the introvert swelling could not be observed in these specimens due to the long unspined distal region, although it is clearly narrow and does not extend proximally far beyond the introvert base.

Temnohaswellia capricornia sp. nov.
(Fig. 7A–E)

ETYMOLOGY. Referring to the Queensland Capricorn region where the worms were collected.

MATERIAL. HOLOTYPE: QMG220098 (WM) from *Euastacus monteithorum* [QMW26634], Kroombit Tops, in rainforest at headwaters of Kroombit Ck in 'Beauty Spot 98', Kroombit Tops SF Qld 24°22'S 150°59'E, Nov–Dec. 1990, L.R.G. Cannon & J.B. Jennings, HW/ Form-Acetic/Un. PARATYPES: QMG220099 (WM) HW/ Form-Acetic/Un; QMG220100–220101 (WM), HW/ Form-Acetic/Hx; QMG220102 (WM), Form/Hx. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26634], QMG220103–220104 (WM), Form/ Hx; QMG220105 (WM), HW/Form-Acetic/Un.; QMG220106–220111 (CP), Form/Fau; QMG220112–220117 (LS[1,1,1,1,1,2]), Form/H&E. OTHER MATERIAL. [unreg. host], QMG220118–220123 (CP), Kroombit Tops, in rainforest at headwaters of Kroombit Ck, Kroombit Tops SF (24°22.2'S 151°00.4'E), 30.01.1997, M. Mathieson & M. Schultz, Fau; [unreg. host], QMG220124–220129 (WM), Kroombit Ck tributary headwaters, Kroombit Tops SF (24°20'S 150°26'E), G.B. Monteith & S.R. Monteith., 70% alc(?)/Un; QMG220130–220132 (WM), 70% alc(?)/Hx; QMG220133–220138 (CP), 70% alc(?)/Fau.; QMG220139–220140 (LS[1,1]), 70% alc(?)/H&E; [QMW27493], QMG221196–221198 (CP), Kroombit Ck headwaters, Kroombit FR Kroombit Ck headwaters, Kroombit FR Qld 24°21.8'S 151°00.4'E, 18.02.2004, H.B. Hines & B. Manning, alc/Fau.

DESCRIPTION. Characteristics of genus but lacking body pigment. Eyes tiny. Selected body measurements of type specimens from *Euastacus*

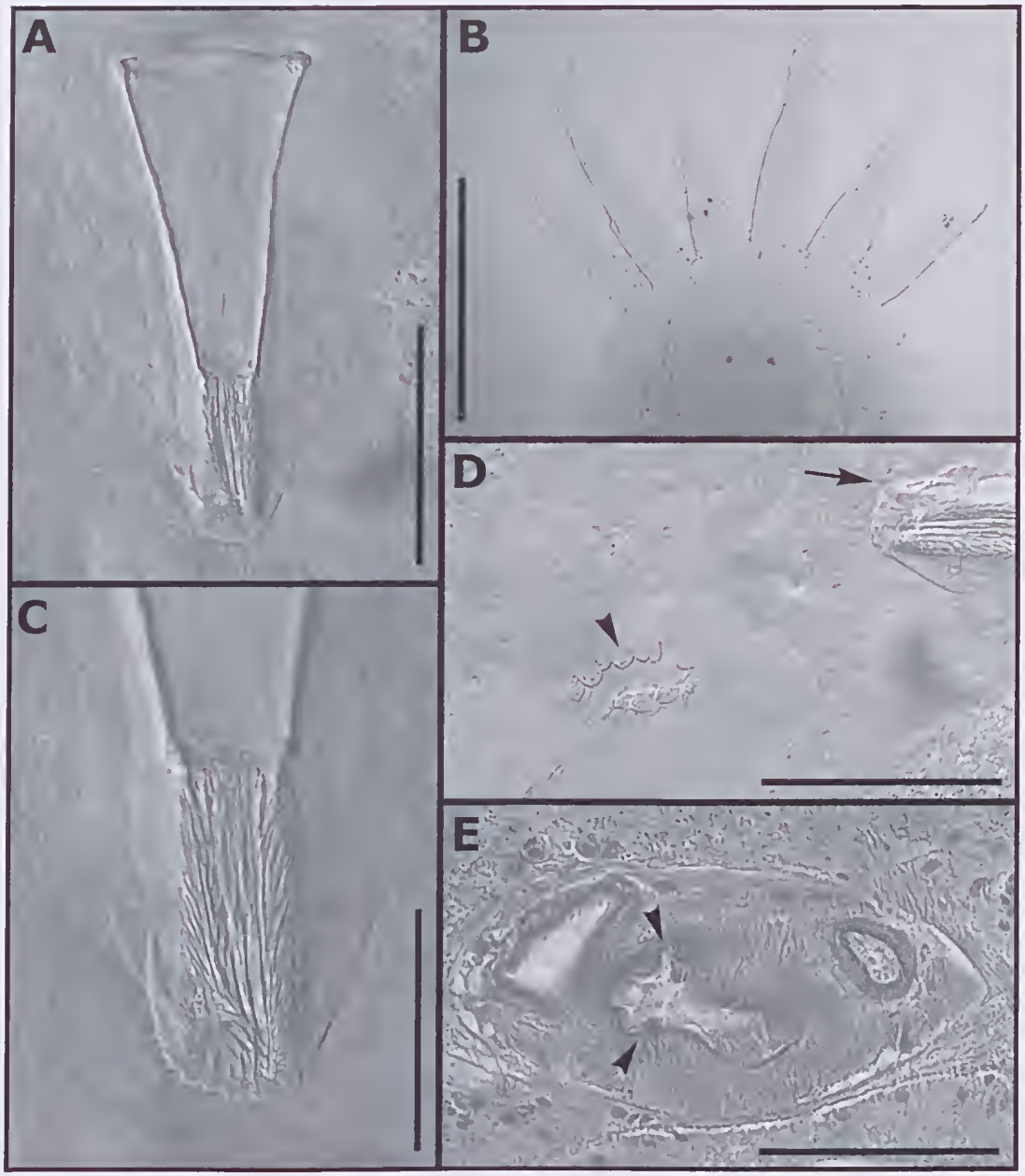


FIG. 7. *Temnohaswellia capricornia* sp. nov. A, C, D, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220119, whole cirrus, scale = 100μm; B, QMG220098, anterior end of worm showing the lack of a concentration of body pigment around the eyes, scale = 500μm; C, QMG220119, introvert, scale = 50μm; D, introvert (arrow) and vagina showing teeth (arrowhead), scale = 100μm; E, QMG220116, longitudinal section through vagina showing teeth in the outer region of the distal vagina (arrowheads), scale = 100μm.

monteithorum are: QMG220098 (H): B(1545 × 756), LE(902), PH(244 × 366); SD(325), PD(167); QMG220099 (P): B(1530 × 816), LE(836), PH(214 × 255); SD(326), PD(163); QMG220101 (P): B(1693 × 959), LE(959), PH(306 × 428); SD(399), PD(163); QMG220102 (P): B(1122 × 857), LE(918), PH(194 × 367); SD(366), PD(211).

Reproductive system. Female. Vagina: Outer region with teeth (when folds sufficiently compressed [as in a concertina]), arranged in numerous (>10) columns and few (2?) rows.

Male. Cirrus: Shaft cone-shaped. Introvert cylinder-shaped; distal opening slightly oblique. Unspined distal region about length of introvert longer side. Swelling even, extending proximally well past introvert base about equally on both sides. Selected cirrus measurements of specimens from *Euastacus monteithorum* from type locality are: QMG220106: S(146 × 59), I(63 × 20), U(53), IS(49 × 49); QMG220107: S(138 × 69), I(49 × 19), U(49), IS(48 × 51); QMG220109: S(130 × 49), I(73 × 18), U(51), IS(51 × 41); QMG220110: S(140 × 51), I(59 × 20), U(61), IS(53 × 49); QMG220111: S(130 × 53), I(53 × 18), U(49), IS(41 × 41).

HOST. *Euastacus monteithorum.*

DISTRIBUTION. Mid-eastern Qld — from the Capricorn region, at Kroombit Tops SF.

REMARKS. This species appears morphologically close to *Temnohaswellia simulator* but can be discriminated on the basis of the cirrus and vagina. *Temnohaswellia capricornia* sp. nov. has fewer rows of teeth in the outer vagina, a cirrus with a longer unspined region, smaller eyes, and lacks a concentration of pigment around the eye region.

Temnohaswellia comes (Haswell, 1893) (Figs 8A–G, 9)

Temnocephala comes Haswell, 1893: 134, pl. 13, figs 15,16.

Temnohaswellia comes: Pereira & Cuocolo, 1941: 103; Joffe & Cannon, 1998: 3, figs 2, 3.

Temnohaswellia pugna Cannon, 1993: 30–31, figs 7, 11g.

ETYMOLOGY. Haswell (1893) provided no derivation of the name. Without doubt it is from the Latin *comes* = companion or associate, evidenced by the observation of Haswell (1924) that *Temnocephala comes* is 'an invariable companion' of *Temnocephala fasciata* [= *Temnosewellia fasciata*] on *Astacopsis serratus* [= *Euastacus* spp.].

MATERIAL. HOLOTYPE AMW388 (WM) from *Astacopsis serratus* [= *Euastacus* spp.], NSW, unknown fixation/U(?). OTHER MATERIAL. From *Astacopsis serratus* [= *Euastacus* spp.] VIC: [unreg. host], NMVF 93695–93697 (CP), Headwaters of Lederberger R., Blackwood (37°35'S 144°24'E), 15.10.1956, unknown fixation/Fau.

From *Euastacus armatus*? [juvenile]. NSW: [QMW26580] QMG219687–219688 (CP), Cudgegong R. at junction with Mill Ck, Wollemi NP (32°50.7'S 150°14.4'E), 20.10.1991, L.R.G. Cannon & K.B. Sewell, Form/Fau.

From *Euastacus australasiensis*. NSW: [QMW27492] QMG221202 (CP) Leura Falls Creek, at Leura Cascades, Blue Mts NP Leura Falls Ck, at Leura Cascades Picnic Area, Blue Mountains NP NSW (33°43.4'E 150°19.5'E) 8.01.2004, D. Blair & R.D. Sewell, alc/Fau.

From *Euastacus brachythorax*. NSW: [QMW26592], QMG219699 (WM), Rutherford Ck crossing on Niten Rd, Brown Mtnn, Glenbog SF (36°36.4'S 149°24.4'E), 13.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG219700–219705 (WM), HW/Form/Un; QMG219706–219707 (WM), HW/Form/Hx; QMG219708–219712 (CP), HW/Form/Fau; QMG219713 (LS[2]), Bouin/ H&E; QMG219714 (LS[2]), Form/H&E.

From *Euastacus clarkae*. NSW: [QMW26598], QMG219715 (WM), Cockerawomheeba Ck at Rimau Rd crossing, Werrikimbe NP (31°11.4'S 152°22.2'E), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG219716 (WM), HW/Form/Un; [QMW26597], QMG219717–219720 (WM), 7.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; [QMW26598], QMG219721–219722 (WM), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Un (WM); [QMW26597], QMG219723 (CP), 7.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Fau; QMG219724–219726 (CP), 70% alc/Fau; QMG219727–219731 (CP), Fau; [QMW26598], QMG219732–219733 (CP), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Fau.

From *Euastacus dangadi*. NSW: [QMW26606], QMG219734–219735 (WM), Eungai Ck trib., at Cedar Crossing, Ngaamba NR, Ingalba SF (30°53.9'S 152°47.3'E), 4.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26605] QMG219736 (WM), 6.02.2002, K.B. Sewell & R.D. Sewell, Bouin/Un; [QMW26606], QMG219737 (WM), 4.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG219738 (WM), HW/Form/Un; QMG219739 (WM), HW/Form/Hx; [QMW26604], QMG219740–219741 (CP), 24.03.2002, K.B. Sewell, 100% alc/Fau; [QMW26606], QMG219742–219745 (CP), 4.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Fau; QMG219746–219747 (LS[3,1]), HW/Form/H&E.

From *Euastacus dharawalus*. NSW: [QMW26607], QMG219748 (WM), Wildes Meadow Ck crossing on Wildes Meadow Rd, Wildes Meadow (34°36.4'S 150°31.1'E), 13.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; QMG219749–219750 (WM), Bouin/Un; QMG219751–219754 (CP), 100% alc/Fau.

From *Euastacus gamilaroi*. NSW: [QMW26620], QMG219755 (WM), Burrows Ck, Sheeba Dams Recreation Reserve, near Hanging Rock (31°30.0'S 151°11.9'E), 22.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG219756 (WM), HW/

Form/Un; [QMW26621], QMG219757, 8.02.2002, Sewell K.B.& Sewell R.D., Fau.

From *Euastacus gumar.* NSW: [QMW26622], QMG219758–219762 (WM), Culmaron Ck, Richmond Ra. NP (28°50.5'S 152°44.1'E), 4.03.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, 100% alc/Bouin/Hx; QMG219763 (CP), 100% alc/Fau; QMG219764–771 (CP), Fau.

From *Euastacus guwinus*? (c.f. *dharawalus*). NSW: [QMW26623]; QMG219772–219777 (WM), Tianjarra Ck, above Tianjarra Falls, Morton NP (35°06.7'S 150°19.8'E) 16.02.2002, K.B. Sewell & R.D. Sewell, Bouin/Un; QMG219778–219782 (CP), Fau.

From *Euastacus hirsutus.* [unreg. host], QMG219799 (WM), Belmore Falls, in stream above falls (34°38.5'S 150°33.3'E CALC), 9.03.1939, Unknown collector, Hx; QMG220246 (LS [2]), unknown fixative/H&E; QMG221010 (LS [1]), unknown fixative/H&E.

From *Euastacus jagara.* Qld: [QMW6471], QMG219800–219802 (WM), Flaggy Ck, Mistake Mts, via Laidley (27°55'S 152°18'E), 2.02.1973 G.B. Monteith & S.R. Monteith., 70% alc/Hx; QMG219803–219804 (WM), 70% alc/Un.; QMG219805–219807 (CP), 70% alc/Fau; QMG219808 (LS[7]), 70% alc/H&E.

From *Euastacus maidae.* Qld: [QMW25590], QMG219809–219811 (WM), Tallebudgera Ck trib., Tallebudgera Valley (near '1000m mark on main track' (28°14.0'S 153°18.5'E) 22.04.2001 D.J. Cook, hot Bouin/Un; QMG219812 (CP), hot Bouin/Fau; [QMW26632], QMG219813 (CP), upper Tallebudgera Ck, at 'Fern Gully' (28°13.7'S 153°18.5'E) 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Fau.; [QMW26631], QMG219814–219819 (WM), upper Currumbin Creek, upstream of old sawmill, 2km E of Mt Cougal (28°14.3'S 153°20.8'E), 11.01.1992, L.R.G. Cannon, K.B. Sewell & J.W. Short, HW/Form/Hx, QMG219820–219822 (LS[1,1,1]), Form/H&E; QMG219823–219829 (CP), HW/Fau/Hx.

From *Euastacus mirangudjin.* NSW: [QMW26633], QMG219830 (WM), Ironpot Ck, Toonumbar NP (28°36.4'S 152°42.1'E), 4.03.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, 100% alc/Un; QMG219831–219833 (CP), 100% alc/Fau.

From *Euastacus neohirsutus.* NSW: [QMW26637], QMG219834–219836 (WM), Little Nymboida R., junction of Lowamnna and Coramba Rds (30°14.0'S 152°55.3'E), 15.02.1992, K.B. Sewell & S.G. Sewell, HW/Form/Hx; [QMW26636], QMG219837–219841 (WM), 16.03.2002, K.B. Sewell, 100% alc/Un; [QMW26637], QMG219842 (WM), 15.02.1992, K.B. Sewell & S.G. Sewell, HW/Form/Hx; [QMW26636], QMG219843–219844 (CP),) 16.03.2002, K.B. Sewell, 100% alc/Fau; [QMW26638], QMG219845–219846 (CP), 5.02.2002 K.B. Sewell & R.D. Sewell; 100% alc/Fau; [QMW26637], QMG219847–219848 (CP), 15.02.1992, K.B. Sewell & S.G. Sewell; QMG219849 (LS[3]), Bouin/H&E; [QMW27494] QMG221201 (CP), 10.02.2004, D. Blair & R.D. Sewell, alc/Fau.

From *Euastacus polysetosus.* NSW: [QMW26641], QMG219850–219853 (WM), Dilgry R., at Dilgry River Picnic Area, Barrington Tops NP, (31°53.6'S 151°31.3'E), 21.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26640], QMG219854–219855 (WM), 9.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; [QMW26641], QMG219856–219858 (WM), HW/Form/Hx; QMG219859 (LS[4]), Form/H&E.

From *Euastacus setosus.* NSW: [QMW26648], QMG219875 (WM), Greenes Falls, at first creek junction downstream, Maiala NP, (27°19.4'S 152°45.8'E), 25.02.1991, L.R.G. Cannon & K.B. Sewell, HW/Form-Acetic/Hx; QMG219876–219877 (WM), HW/Form-Acetic/Un; QMG219878 (WM), HW/Form-Acetic/Hx; QMG219879–219880 (CP), HW/Form-Acetic/Fau; [QMW26649], QMG219881–219884 (CP), 1.10.2002, K.B. Sewell & S.G. Sewell, 100% alc/Fau.

From *Euastacus* sp. NSW: [QMW26581], QMG219675–219680 (WM), Cudgegong R. at junction with Mill Ck, Wollemi NP (32°50.7'S 150°14.4'E), 11.02.2002 K.B. Sewell & R.D. Sewell, 100% alc/Un; QMG219681 (CP), 100% alc/Fau; QMG219682–219686 (CP), Fau.

From *Euastacus spinichelatus.* NSW: [QMW26653], QMG219885–219888 (WM), Joyces Ck, Oxley Hwy crossing, 6km SE of Yarrowitch, Enfield SF (31°16.7'S 151°58.3'E), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26652], QMG219889 (WM), 6.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; QMG219890 (WM), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG219891–219893 (WM), HW/Form/Un; [QMW26652], QMG219894–219896 (CP), 6.02.2002, K.B. Sewell & R.D. Sewell 100% alc/Fau; [QMW26653], QMG219897–219903 (CP), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Fau; QMG219904 (LS[2]), Form/Hx; QMG219905 (LS[2]), Bouin/H&E.

From *Euastacus spinifer.* NSW: [QMW26585], QMG219689–219694 (WM), Jamieson Ck, 0.5 km above Wentworth Falls, beside Darwin's Walk, (33°43.6'S 150°22.5'E), 12.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; QMG219695 (CP), 100% alc/ Fau; QMG219696–219698 (CP), Fau; [QMW26642], QMG219860 (WM), Problem Ck crossing on Frying Pan Rd, trib. of Telegherry R., Chichester SF, 1km E of Telegherry FP (32°13.6'S 151°45.8'E), 10.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; QMG219861–219862 (WM), hot Bouin/Un; QMG219863–219864 (WM), 70% alc/Un; QMG219865 (WM) hot Bouin/Un; QMG219866 (WM) 70% alc/Un; QMG219867–219874 (CP), 100% alc/Fau; [QMW27490], QMG221203 (CP), 9.01.2004, D. Blair & R.D. Sewell, alc/Fau; [QMW26654], QMG219906–219910 (WM), Mammy Johnsons Ck, at road bridge near Nature Reserve just SE of Stroud Road township (32°21.1'S 151°56.1'E),

21.11.1996, K.B. Sewell & R.D. Adlard., Bouin/Hx; QMG219911–219913 (MP), QMG219914–219921 (CP), 100% alc/Fau; [QMW20765], Karuah R. at Washpool Bridge (32°19'S 151°57'S), 28.08.1995, J. & R. Powell; QMG219922 (WM) hot Bouin/Un; QMG219923 (CP), 70% alc/Fau.

From *Euastacus sulcatus*. Qld: [QMW18000 & QMW26656], QMG219929–219931 (WM), Mosses Well, Spicers Gap, Main Ra. NP (28°04.0'S 152°26.3'E), 25.11.1991, K.B. Sewell & C. Lee, HW/Form/Hx; QMG219932–219933 (WM), Bouin/Un; QMG219934 (WM), HW/Form/Hx; QMG219935 (WM) HW/70% alc/HX; QMG219936 (LS[2]), HW/70% alc/H&E; QMG219937–219938 (LS[1,1]), HW/Form/H&E; QMG219939 (CP), HW/70% alc/Fau; [unreg. host, ident. Dr John Short, QM], 1.09.1994, K.B. Sewell, QMG219940–219946 (CP), HW/deF. [unreg. host, ident. Dr John Short, QM], QMG219947–219948 (WM), Mt Huntley (spring beside walking track nr summit), Main Ra. NP (28°08.8'S 152°26.6'E), 30.01.1993, G.B. Monteith, HW/Bouin/Hx; QMG219949 (LS[1]), HW/Bouin/H&E. [QMW26658], QMG219950–219954 (WM), upper Tallebudgera Ck, at 'Fern Gully' (28°13.7'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un; QMG219955–219956 (CP), 100% alc/Fau; [QMW26657] QMG219957 (WM), upper Tallebudgera Ck, at '1000m mark on main track' (28°14.0'S, 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un; QMG219958 (CP), 100% alc/Fau. [QMW6462], Levers plateau via Rathdowney (28°20'S 152°52'E), 6.10.1973, S.R. Monteith, QMG219959–219960 (WM), 70% alc/Hx; QMG219961–219963 (LS[1,1,1]), 70% alc/H&E. NSW: [QMW26655], QMG219964–219966 (WM), Bundoozle Flora Reserve, Richmond Ra. NP (28°36.4'S 152°42.1'E), 4.3r.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, 100% alc/Un; QMG219967 (WM), 100% alc/Bouin/Un; QMG219968–219969 (CP), 100% alc/Fau; QMG219970–219972 (CP), Fau.

From *Euastacus suttoni*. Qld: [QMW26660], QMG219973–219974 (WM), beside rd to The Pyramids, Girraween NP (28°49.1'S 151°58.8'E), 18.04.1990, S. Cook, AFA/Hx; QMG219975–219979 (CP), HW/70% alc/Fau; QMG219980 (CP), Bouin/Fau; QMG220173, QMG219981 (LS[2,1]) Bouin/H&E; QMG219982, QMG212984 (LS[2,2]), Formal-Acetic/H&E; QMG219985 (LS[2]), Bouin/H&E. NSW: [QMW26661], QMG219986–219987 (WM), Washpool Ck, nr Thunderbolts Hideout, N of Tenterfield, (28°58.4'S 152°04.4'E), 19.12.2001, K.B., S.G., R.D. & M.R. Sewell, 70% alc/Un; [QMW26663], QMG219988–219990 (WM), 4.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; [QMW26661], QMG219991–219992 (WM), 19.12.2001, K.B., S.G., R.D. & M.R. Sewell, 70% alc/Un; [QMW26663], QMG219993 (WM), 70% alc/Un; QMG219994 (WM), 4.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; [QMW26661], QMG219995–219996 (CP), 19.12.2001, K.B., S.G., R.D. & M.R. Sewell, 100% alc/Fau; QMG219997–220001 (CP), Fau; QMG220002–220003 (CP), 70% alc/Fau. [QMW6469], QMG220004–220005 (WM), Poverty Point, nr Tenterfield (29°08'S 152°20'E), 23.10.1973, S.R. Monteith, 70% alc(?)/Hx; QMG220006–220007 (LS [1,1]), 70% alc(?)/H&E; QMG220008–220011 (CP), 70% alc(?)/Fau. [QMW6468], QMG220012–220013 (WM), Gibralter Ra. NP (29°35'S 152°13'E), 19.12.1972, S.R. Monteith, 70% alc(?)/Hx; QMG220014 (CP), 70% alc(?)/Fau; QMG220015–220017 (LS[1,1,4]), 70% alc(?)/H&E. [QMW26662], QMG220018–220019 (WM), Glen Innes, Dec. 1976, I. Kneipp, 70% alc/Hx; QMG220020 (CP), 70% alc/Fau; QMG220021–220022 (LS[1,1]), 70% alc/H&E.

From *Euastacus valentulus*. Qld: [QMW26666], QMG220023–220025 (WM), D.J. Cook, 2.02.1990 Tallebudgera Valley (28°08'S 153°26'E), 2.02.1990, D.J. Cook, 70% alc/Hx; QMG220026–220067 (LS[1,2]), 70% alc/H&E; [QMW26668], QMG220028 (WM), Cougal Ck, in cleared paddock nr 'Twin Pools', upper Tallebudgera Valley (28°12.8'S 153°20.4'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell; QMG220029–220032 (CP), 100% alc/Fau; [QMW25589], QMG220033 (CP), 8.11.2000, D.J. Cook, Fau; [QMW26667], QMG220034–220039 (WM), upper Tallebudgera Ck, at 'Fern Gully' (28°13.7'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un; QMG220040–220041 (CP), 100% alc/Fau. NSW: [QMW6459], QMG220042–220047 (WM), Rocky Ck rainforest, Whian Whian SF, (28°40'S 153°18'E), Jul. 1974, G.B. Monteith & S.R. Monteith., 70% alc/Un; QMG220048–220053 (CP), 70% alc/Fau.

From *Euastacus yanga*. NSW: [QMW26626], QMG219783–219785 (WM), Burrawang Ck at road crossing, 3km NW Belmore Falls, Morton NP, (34°37.1'S 150°32.5'E), 13.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; [QMW26627], QMG219786–219789 (WM),19.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26626], QMG219790 (WM), 13.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; QMG219791 (CP), 100% alc/Fau; QMG219792–219797 (CP), Fau; [QMW26627], QMG219798 (LS[3]), 19.10.1991, L.R.G. Cannon & K.B. Sewell, Form/H&E.

From *Caridina* sp. (*nilotica*?) (Crustacea: Decapoda; Atyidae). [Spurious record, see remarks below]. Qld: [unreg. host] QMGL 14579 (WM), ex, Aplin Weir, on Ross R., Townsville, Qld (19°22'S 146°44'E), L. Winsor, Form/Picrocarmine.

From *Hyridella (Hyridella) depressa* (Lamark, 1819). (Mollusca: Bivalvia; Unionoidea: Hyriidae) [spurious record, see remarks]. VIC: [unreg. host], NMVF 93698–93702 (CP), Forrest (38°31'S 143°43'E), 1948, A. Wilhelms, unknown fixation/Fau; NMVF 93704–93705 (LS[1,1]) unknown fixation/H&E(?).

DESCRIPTION. Characteristics of genus and essentially as described by Haswell (1893;

1924) in lacking body pigment, but occasionally with thin scatter of pigment between the eyes as figured by Cannon (1993: fig. 7a). Selected body measurements of type specimen from *Astacopsis serratus* [*Euastaens* spp.] are: AMW388 (TYPE): B(2142 × 1122), LE(1479), PH(285 × 472), SD(488), PD(244). Selected body measurements of specimens from *Euastacus spinifer* are: QMG219689: B(2142 × 1122), LE(1408), PH(388 × 408), SD(408), PD(204); QMG219690: B(2040 × 1081), LE(1428), PH(326 × 449), SD(469), PD(245); QMG219691: B(2101 × 1122), LE(1530), PH(408 × 490), SD(490), PD(286); QMG219692: B(1999 × 1020), LE(1346), PH(326 × 490), SD(449), PD(204); QMG219693: B(2081 × 1489), LE(1510), PH(347 × 530), SD(510), PD(286).

Reproductive system. Female. Vagina: Outer region weakly sclerotised, lacks teeth; vaginal cavity as figured by Haswell (1924: plate LVI, fig. 16), 'sac-like' with expanded (bulging) equatorial region, folded into obvious longitudinal and circumferential rows of small papillate crenulations, with pattern similar to knitted sock top.

Male. Cirrus: General form as figured by Haswell (1893: plate XIII, fig. 15). Shaft cone-shaped. Introvert essentially as figured by Haswell (1893: plate XIII, fig. 16), with sharply-narrowed introvert base, scoop-shaped; distal opening oblique. Small introvert spines appear optically in rows oriented diagonal to long axis of introvert (i.e. reminiscent of the surface topography of a pineapple as figured by Cannon (1993: fig 7b). Large spines (about 10 total [about 30–40 long]) positioned uniformly around and projecting distally from circumference of circular rim just distal to introvert base as figured by Cannon (1993: fig 7b). Unspined distal region about two thirds length of introvert longer side. Swelling very uneven, much larger on longer side, extending proximally well past introvert base on longer side and very short distance on the shorter side. Selected cirrus measurements of type specimen from *Astaeopsis serratus* [*Euastaens* spp.] are: AMW388 (Type): S(309 × 122), I(114 × 26), U(71), IS(110 × 18).

Selected cirrus measurements of specimens from *Euastaens spinifer* are: QMG219695: S(389 × 114), I(130X 36), U(71), IS(127 × 18); QMG219696: S(232 × 77), I(106 × 26), U(77), IS(102 × 18); QMG219697: S(232 × 95), I(98 × 30), U(75), IS(128 × 14); QMG219698: S(217 × 93); I(108 × 30), U(65), IS(114 × 16).

Epidermal Mosaic. See generic diagnosis.

HOSTS. *Astacopsis serratus* (= *Euastacus* spp.], *Euastacus armatus*?, *E. brachythorax*, *E. clarkae*, *E. dangadi*, *E. dharawhalus*, *E. gamilaroi*, *E. gunar*, *E. guwinus*? (c.f. *dharawalus*?), *E. hirsutus*, *E. jagara*, *E. maidae*, *E. mirangudjin*, *E. neohirsutus*, *E. polysetosus*, *E. setosus*,*E.* sp., *E.* sp. nov.?, *E. spinichelatus*, *E. spinifer*, *E. sulcatus*, *E. suttoni*, *E. valentulus*, *E. yanga*.

DISTRIBUTION. Southern Qld to south-eastern VIC — widespread along the Great Dividing Ra..

REMARKS. The type specimen of *Temnohaswellia eomes*, in conjunction with the species descriptions of Haswell (1893; 1924), allow us to confidently refer our specimens to the species. The description and figures of the female reproductive system by Haswell (1924) leaves little possibility of confusion with other species. Sections revealed the distal opening to the genital atrium to indeed be ringed by small papillae identifiable as the 'circlet of papillae' described and figured by Haswell (1924: page 512, plate LV, fig. 12; plate LVI, fig. 16) (Fig. 8F). These papillae are not easily seen in either whole mounted specimens or those cleared in Faure's medium. We were unable to find similar structures in any other species of *Temnohaswellia* examined in this study although we often had only limited sectioned material available. We cannot, therefore, exclude the possibility that similar papillae occur in other species.

Details of the cirrus are essentially as figured by Haswell (1893: plate XIII, figs 15 & 16) as can be seen from the Faure's preparations (Fig. 8A–C, E, G). The largest discrepancy with the original descriptions is that he (Haswell, 1893; 1924) did not mention the large spines that we observed invariably to be attached to the cirrus introvert base and which are definitely present in the type specimen (Fig. 8B). This oversight is surprising although Haswell (1893: plate XIII, fig. 6) did draw three longitudinal lines from the base of the introvert that are consistent with the position of these spines. The ejaculatory sac is present and as figured by Haswell (1893: plate XIII, fig. 15).

Temnohaswellia eomes occurs on more host species than does any other member of the genus. The geographical distribution of the worm is extensive and overlaps most closely with that of *Temnohaswellia simulator*. The worm was observed to frequently co-occur with either *Temnohaswellia verruca* sp. nov. or *T. simulator*, and sometimes with *T. cornu* sp. nov., on the same host individual. The specimens selected for measurement and comparison, came from

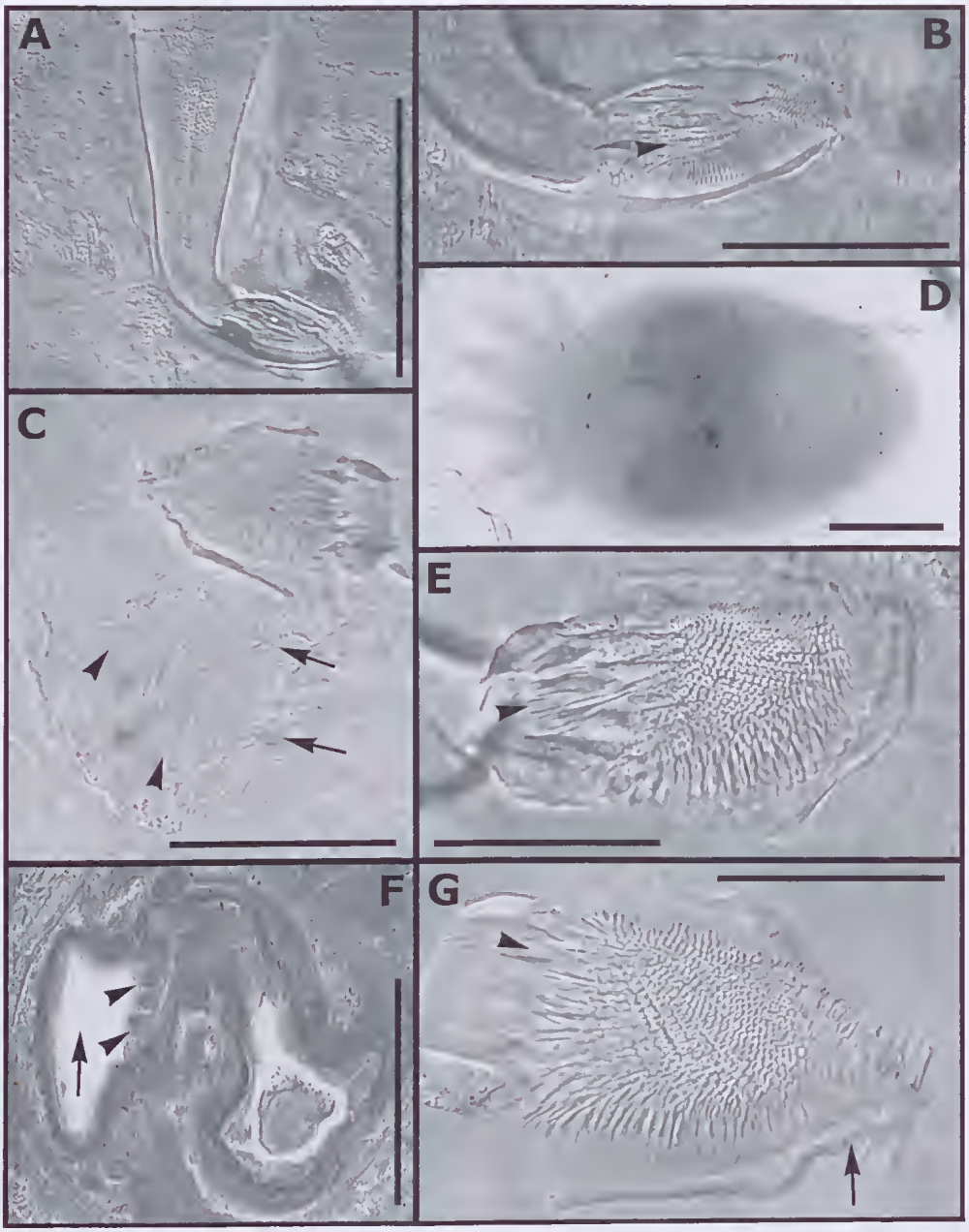


FIG. 8. *Temnohaswellia comes* A–C, E, G, Nomarski interferenee eontrast photomierographs of Faure's preparations. A, AMW388 (Holotype), whole eirrus (stitehed image), seale = 250µm; B, AMW388, introvert showing large basal spines (arrowhead), seale = 100µm; C, QMG219695, speeimen from Wentworth Falls, NSW, introvert and 'sae-like' vagina showing rows of longitudinal (arrows) eireumferential (arrowheads) papillate erenulations, scale = 100µm; D, AMW388 (Type), Dorsal view of wholemount, scale = 500µm; E, QMG219958, introvert showing large basal spines (arrowhead), specimen from Tallebudgera Ck, Qld, seale = 50µm; F, QMG220173, longitudinal seetion through vagina showing putative 'eirelet of papillae' (arrowheads) in the distal vagina at the opening to the genital atrium (arrow), specimen from Girraween NP, Qld, seale = 100µm; G.QMG219695, introvert showing large basal spines (arrowhead) and the junetion of the unspined distal region (arrow) and the spiny introvert, seale = 50µm.

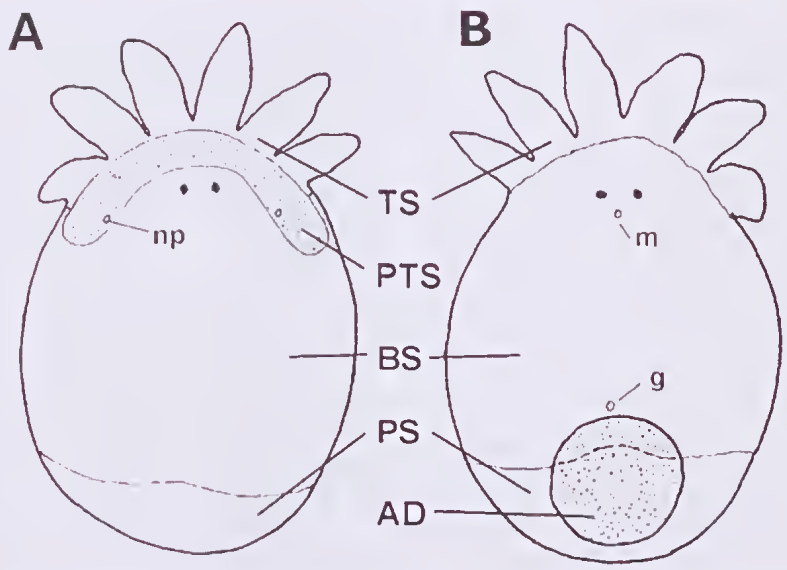


FIG 9. Mosaic of epidermal syncytia for *Temnohaswellia comes* from *Euastacus spinifer* [QMW26654] from the Karuah R., NSW in (A) dorsal view, (B) ventral view; AD, adhesive disc syncytium; BS, body syncytium; PS, peduncular syncytium; PTS, post-tentacular syncytium; TS, tentacular syncytium; g, gonopore; m, mouth; np, nephridiopore - derived from 3 specimens: QMG219911–219913.

a host, *Euastacus spinifer*, and a locality, Wentworth Falls, NSW near the middle of the known geographical range and from where we had good specimens.

The record from the freshwater, unionid bivalve, *Hyridella (Hyridella) depressa*, warrants discussion. Temnocephalans are associates of fresh water mollusc hosts in South America (see for example, Haswell, 1893; Damborenea & Cannon, 2001) but not in Australia. We believe, therefore, that it is very likely that the finding of temnocephalans with *Hyridella (Hyridella) depressa* is a consequence of placement of the mollusc and crayfish together in the same container during field collection and is thus an error. Temnocephalans are small, frequently unpigmented and readily detach from their hosts. The possibilty of cross contamination between 'hosts' must be carefully guarded against.

Cannon (1993) described *Temnohaswellia pugna* from a single holotype wholemounted specimen reputedly collected from the freshwater shrimp, *Caridina* sp. (*nilotica*?) at Townsville. After examination of the holotype of *Temnohaswellia pugna* and the type of *T. comes*, we now consider that the two species are one and the same based on the shape of the cirrus and the large basal spines on the introvert. We now also consider that the reported association of *Temnohaswellia pugna* with a shrimp host is an error in the light of the following evidence. Collection records kindly provided by L. Winsor for the batch of specimens that included *Temnohaswellia pugna*, also list temnocephalans from *Euastacus suttoni* [QMW26662], collected at Glen Innes, NSW, a host from which we have subsequently identified both *T. comes* and *T. simulator*. Our repeated attempts to obtain further specimens of this species (*Temnohaswellia pugna*) from extensive sampling of shrimps at the 'type locality' in Townsville have proven unsuccessful.

The epidermal mosaic of *Temnohaswellia comes* was revealed to be identical to that described and photographed from worms identified tentatively as *Temnohaswellia comes* by Joffe & Cannon (1998: fig. 2a, 3f). Now able to be confirmed as *Temnohaswellia comes*, these worms were obtained from *Euastacus sulcatus* collected on 1.09.1994, by K.B. Sewell at Spicers Gap, Main Ra. NP, Qld (28°04.0'S 152°26.3'E). The host was identified by Dr John Short, QM.

Temnohaswellia cornu sp. nov.
(Fig. 10A–D)

ETYMOLOGY. From *cornu* = horn (Latin, neuter) — a reference to the oxen horn-shaped cirrus.

MATERIAL. HOLOTYPE: QMG220314 (WM), from *Euastacus jagara* [QMW6471], Flaggy Ck, Mistake Mts, via Laidley, Qld, (27°55'S 152°18'E), 2.02.1973, G.B. Monteith & S.R. Monteith., 70% alc/Un. PARATYPES: QMG220315–220316 (WM) ,70% alc/Un; QMG220317–220318 (WM), 70% alc/Hx. OTHER MATERIAL FROM TYPE LOCALITY: QMG220319–220320 (WM), 70% alc/Hx; QMG220321–220322 (WM), 70% alc/Un; QMG220323–220329 (CP), 70% alc/Fau; QMG220330–220332 (LS[1,1.1]), 70% alc/H&E.

DESCRIPTION. Characteristics of genus but lacking body pigment. Selected body measurements of type specimens from *Euastacus jagara* are: QMG220314 (H): B(1016 × 585), LE(732), PH (195 × 240), SD(301). PD(130); QMG220315 (P): B(1398 × 732), LE(972), PH (268 × 301), SD(341), PD(187); QMG220316 (P): B(1398 × 837), LE(1000), PH (276 × 325), SD(390), PD(195); QMG220317 (P): B(1382 × 740), LE(919), PH (260 × 333), SD(301), PD(228); QMG220318 (P): B(1398 × 829), LE(1114), PH (325 × 333), SD(415), PD(228).

Reproductive system. Female. Vagina: Outer region weakly sclerotised, lacking teeth.

Male. Cirrus: Shaft cone-shaped. Introvert cylinder to scoop-shaped; distal opening not obviously oblique. Unspined distal region short, about one third length of introvert longer side. Swelling even, extending proximally moderate distance past introvert base on both sides, slightly farther on longer side. Selected cirrus measurements of specimens from *Euastacus jagara* from type locality are: QMG220323: S(126 × 75), I(51 × 24), U(18), IS(16 x 16); QMG220324: S(106 × 55), I(55 × 24), U(18); IS(12 X8); QMG220328: S(134 × 73), I(57 × 24), U(22), IS(24 X20); QMG220329: S(128 × 57), I(57 × 24), U(20), IS(24 X20).

HOST. *Euastacus jagara.*

DISTRIBUTION. South-eastern Qld — at Flaggy Ck, Mt Mistake, Main Ra. NP.

REMARKS. This worm resembles *Temnohaswellia simulator* in the shape and dimensions of the cirrus, however it lacks the distinctive vaginal teeth of *T. simulator*. Moreover, it lacks the concentration of pigment in the eye region. The distal vagina is thickly muscled compared to most Australian species and the cavity is frequently near-spherical.

Temnohaswellia crotalum sp. nov.
(Fig. 11A–E)

ETYMOLOGY. From *krotalon* = rattle (Greek, neuter); a reference to the prominent folds of the sclerotised inner lining of the distal region vagina reminiscent of the rattle of a rattle-snake.

MATERIAL. HOLOTYPE: QMG220208 (WM), from *Euastacus kershawi* [QMW26630], Labertouche Ck (Tarago R. trib.), on Old Telegraph Rd, W of Jindivick, VIC (38°03.2'S 145°50.1'E), 21.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un. PARATYPES: QMG220209–220212 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220213 (WM), 100% alc/Un; QMG220214–220217 (CP), 100% alc/ Fau. OTHER MATERIAL. From *Euastacus bispinosus.* VIC: [QMW26591], QMG220218 (WM), Jimmys Ck, at picnic ground 6.5 km WNW Mafeking (37°23'S 142°34'E), 5.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG220219–220220 (WM), HW/Form/Un; QMG220221 (CP), HW/Form/Fau.

From *Euastacus neodiversus.* VIC: [QMW26354], QMG220222–220228 (WM), Tarra R., 50 m above Tarra Falls, Tarra Valley NP (38°29'S 146°36'E) 10.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG220229–220234 (CP), HW/Form/Fau; QMG220235–220236 (LS[2,1]), Form/H&E; QMG220237–220238 (LS[3,4]), Bouin/H&E.

From *Euastacus woiwuru.* VIC: [QMW26669], QMG220239–220241 (WM), Dobsons Ck at crossing Alpine Rd nr junction with Mountain HigHwy, Ferntree Gully SF, Dandenongs (37°52.3'S 145°20'E), 22.03.2002, K.B. Sewell, 100% alc/Un; QMG220242–220244 (CP), 100% alc/Fau; [QMW26668], QMG220245 (LS[3]), 7.10.1991, L.R.G. Cannon & K.B. Sewell, Form/H&E.

From *Euastacus yarraensis.* VIC: [NMV J 6156], NMVF 93722 (CP), Bunyip River, top of road from Princes HigHwy (37°55'S 145°43'E), 18.02.1977, P.S. Lake, 70% alc(?)/Fau: [QMW26673], QMG220247–220248 (WM), Labertouche Ck (Tarago R. trib.), on Old Telegraph Rd, W of Jindivick (38°03.2'S 145°50.1'E), 8.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG220249–220250 (LS[1]), Bouin/H&E; [unreg. host], QMG 221204 (CP), Love Ck, at picnic ground, Kawarren, Otways (38°28.8'E 143°35.0'E), 1.01.2004, D. Blair, R.D. Sewell, S.H. Lawler & G.N. Edney, alc/Fau.

From 'fresh water cray' VIC: [unreg. host], NMVF 93706–93708, (WM), Fern Tree Gully (37°53'S 145°18'E), 18.02.1872, unknown fixation/Carmine(?); NMVF 93709–93718 (CP), unknown fixation/Fau;

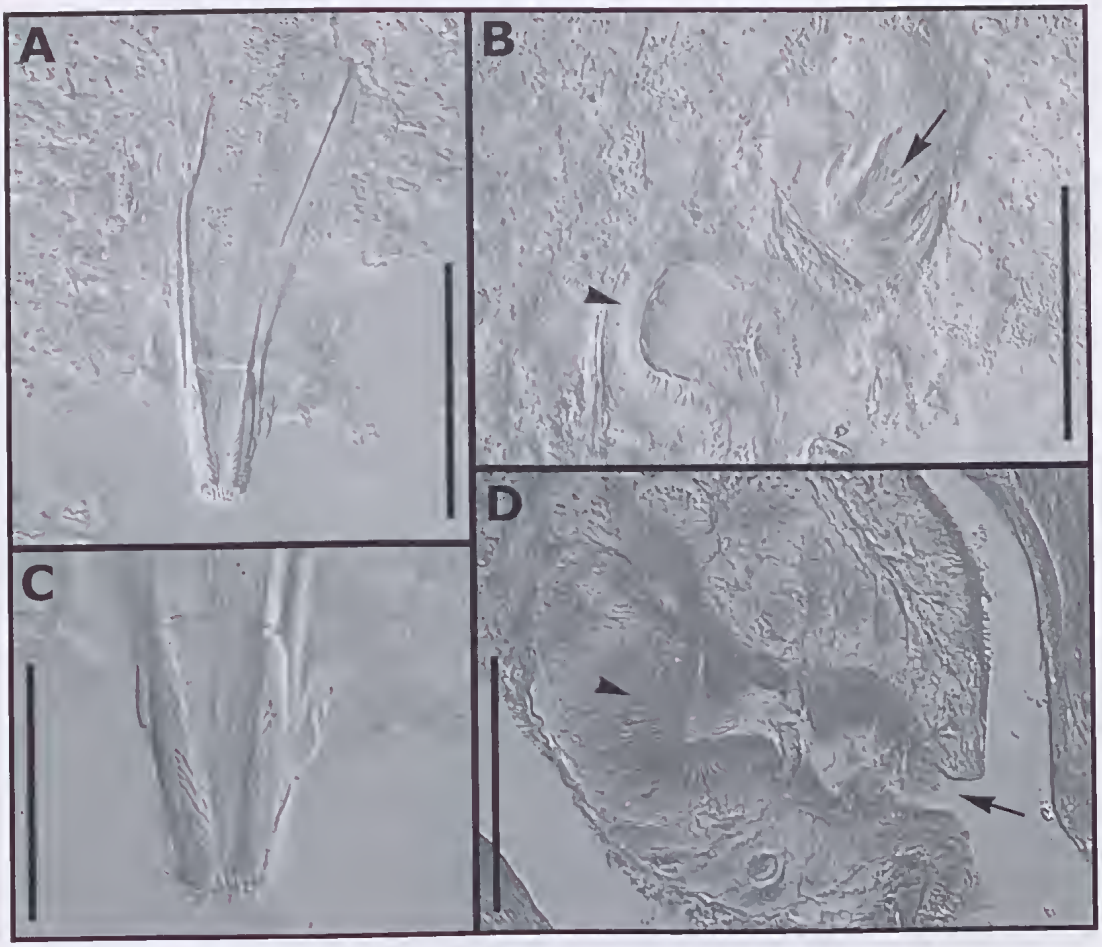


FIG. 10. *Temnohaswellia cornu* sp. nov. A–C, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220323, whole cirrus, scale = 100µm; B, QMG220326, introvert (arrow) and vagina showing strong musculature in the distal region (arrowhead), scale = 100µm; C, QMG220323, introvert, scale = 50µm; D, QMG220326, longitudinal section through vagina showing strong musculature of the the distal vagina (arrowhead) and common gonopore (arrow), scale = 100µm.

NMVF 93719–93721 (LS[1,1,2]), unknown fixation/ H&E(?).

DESCRIPTION. Sometimes large worm showing eharaeteristies of genus but laeking body pigment exeept for oeeasionally a thinly seattered pigment between the eyes. Seleeted body measurements of type speeimens from *Euastacus kershawi* are: QMG220208 (H): B(2978 × 2020), LE(2224), PH(714 × 877), SD(654), PD(428); QMG220209 (P): B(3162 × 2224), LE(2836), PH(796 × 775), SD(734), PD(510); QMG220210 (P): B(3121 × 1408), LE(2428), PH(694 × 816), SD(612), PD(367); QMG220211 (P): B(2917 × 1469), LE(2346), PH(653 × 796), SD(653), PD(388); QMG220212 (P): B(2754 × 1367), LE(1999), PH(571 × 571), SD(592), PD(306).

Reproductive system. Female. Vagina: Outer region tapers rapidly proximally, with bloek-like teeth inereasingly larger proximally arranged in very obvious eolumns (8?) and rows (8?).

Male. Cirrus: Shaft eone-shaped. Introvert seoop-shaped; distal opening oblique. Unspined distal region about two thirds length of introvert longer side. Swelling uneven, extending proximally well past introvert base on both sides, eonsiderably farther on longer side. Seleeted eirrus measurements of specimens from *Euastacus kershawi* from type loeality are: QMG220214: S(209 × 108), I(94 × 26), U(61), IS(118 × 28);

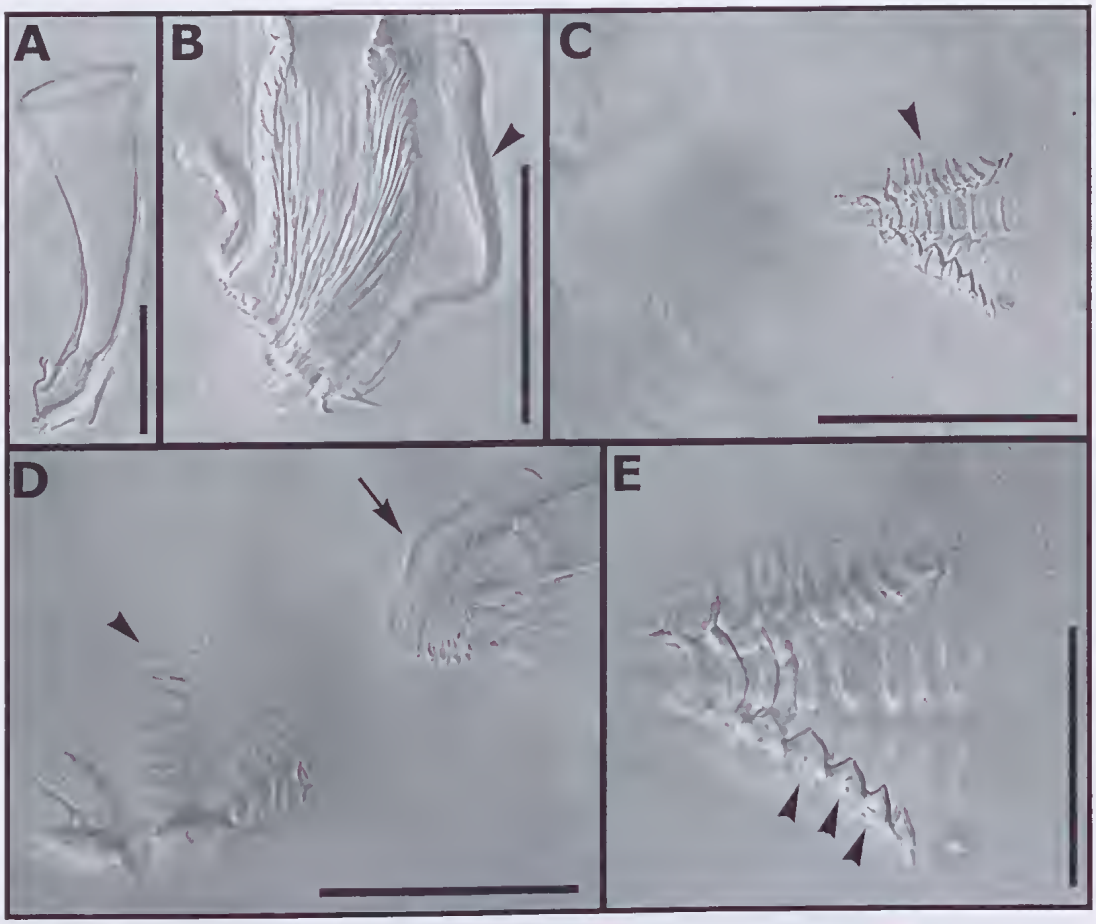


FIG. 11. *Temnohaswellia crotalum* sp. nov. A–E, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220215, whole cirrus, scale = 100µm; B, QMG220215, introvert showing unspined distal region (arrowhead), scale = 50µm; C, QMG220215, vagina showing musculature and distinctive block-like teeth in the distal region arranged in columns and rows (arrowhead), scale = 100µm; D, QMG220217, introvert (arrow) and vagina showing distinct vaginal teeth (arrowhead), scale = 100µm; E, QMG220215, vagina showing distinctive block-like teeth arranged in the distal region arranged in rows (arrowheads), scale = 50µm.

QMG220215: S(224 × 96), I(100 × 24), U(69), IS(144 × 65); QMG220216: S(230 × 116), I(94 × 30), U(65), IS(118 × 14); QMG220217: S(242 × 110), I(96 × 28), U(61), IS(112 × 51).

HOSTS. *Euastacus bispinosus, E. kershawi, E. neodiversus, E. woiwuru, E. yarraensis.*

DISTRIBUTION. Southern VIC — from Tarra Vally NP at Tarra Falls; W of Jindivick at Labertouche Ck; Dandenongs Ra. at Fern Tree Gully; near Bunyip, at Bunyip R. South-western VIC — from Grampians NP at Jimmys Ck.

REMARKS. The distinctive shape and arrangement of the distal vagina serve to clearly distinguish this species, and make it one of the easiest to identify when the teeth are present and clearly seen. Young worms with undeveloped vaginal teeth, or females viewed with the vagina in a position where the vaginal teeth are not seen, can be misidentified as *Temnohaswellia verruca* sp. nov. Despite the distinctive vaginal teeth of adult worms, the cirrus does not appear to have large spines that would relate directly to these structures. We have not, however, observed the spines with the cirrus everted.

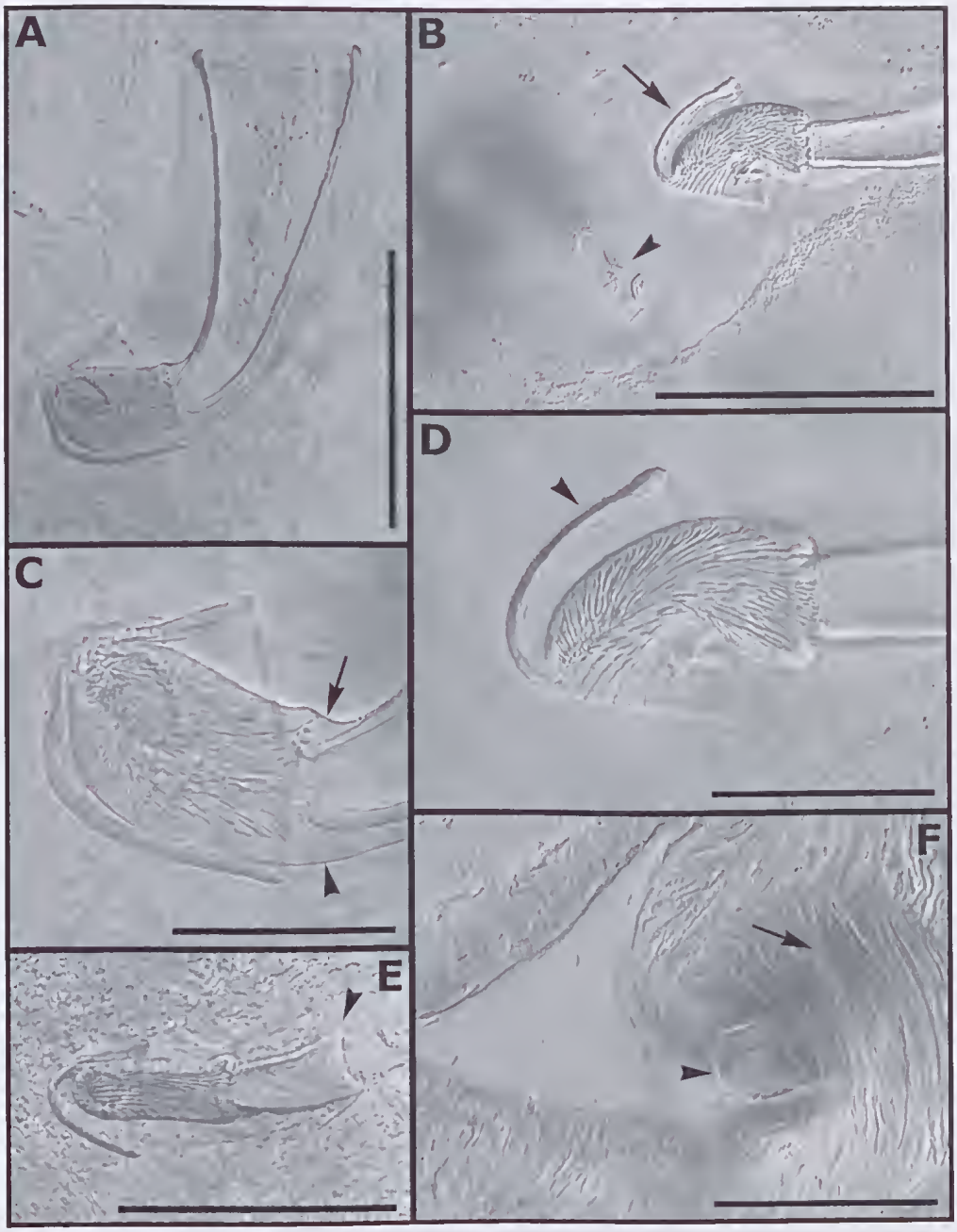


FIG. 12. *Temnohaswellia munifica* sp. nov. A–E, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220254, whole cirrus, scale = 250μm; B, QMG220260, introvert (arrow) and vagina showing large teeth (arrowhead) in the outer region of the distal vagina, scale = 250μm; C, QMG220254, introvert showing uneven swelling extending well past the introvert base on the longer side (arrowhead) and just past the introvert base on the shorter side (arrow), scale = 100μm; D, QMG220260, introvert showing unspined distal region (arrowhead) that appears like a semicircular cap, scale = 100μm; E, QMG220255, introvert of young specimen showing short shaft with a narrow proximal opening (arrowhead), scale = 250μm; F, QMG220257, vagina longitudinal section showing large tooth structure (arrowhead) and strong proximal muscular sphincter (arrow), scale = 50μm.

Temnohaswellia munifica sp. nov.
(Fig. 12A–F)

ETYMOLOGY. From *munifica* = noble (Latin); a reference to the noble cirrus.

MATERIAL. HOLOTYPE: QMG220251 (WM), from *Euastacus hystricosus* [unreg. host], Booloumba Ck, 'beauty spot 100', Conondale Ra. (26°39'S 152°39'E), 18.06.1986, Unknown collector, 70% alc(?)/Un. PARATYPES: QMG220252–220253 (WM), 70% alc(?)/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220254 (CP), 70% alc(?)/Fau. [QMW6461], QMG220255–220256 (CP), Booloumba Ck, Conondale Ra. (26°39.0'S 152°38.7'E), 29.11.1974, G.B. Monteith & S.R. Monteith, 70% alc/Fau. OTHER MATERIAL. From *Euastacus hystricosus*. Qld: [unreg. host], QMG220259 (WM); Little Yabba Ck, Conondale SF, 17.11.1983, L.R.G. Cannon & J.B. Jennings, Form-Acetic/Hx; QMG220257–220258 (LS[10, 4]), Form-Acetic/H&E; [unreg. host, ident. Dr Mark Ponniah, Griffith University], QMG220260 (CP), Stony Ck, Stony Ck SF (26°51.7'S 152°44.0'E), 100% alc/Fau.

DESCRIPTION. Large worm lacking body pigment. Selected body measurements of type specimens from *Euastacus hystricosus* are: QMG220251 (H): B(3835 × 2020), LE(2958), SD(836), PD(490), PH(1081 × 898); QMG220252 (P): B(4223 × 2224), LE(3672), SD(1020), PD(775), PH(1530 × 1306); QMG220253 (P): B(3060 × 2081), LE(2856), SD (673), PD(428), PH(1530 × 959).

Reproductive system. Female. Vagina: Outer region with large triangular teeth, increasingly and rapidly smaller proximally, arranged in columns (6?) and rows (4?).

Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped with sharply narrowed introvert base; distal opening very oblique. Unspined distal region slightly less than length of introvert longer side. Swelling uneven to very uneven, extending proximally well past introvert base on longer side and shorter distance past introvert base on shorter side. Selected cirrus of specimens from *Euastacus hystricosus* from type locality are: QMG220254: S(380 × 150), I(163 × 37), U(132), IS(106 x 30); QMG220255 [juvenile]: S(122 × 57), I(144 × 35), U(136), IS(na x na); QMG220256 [juvenile]: S(37 × 57), I(170 × 39), U(130), IS(na x na).

Selected cirrus measurements of specimens from other *Euastacus hystricosus* are: QMG220260: S(217 × 41); I(153 × 41), U(132), IS(>55 x 71).

HOST. *Euastacus hystricosus*.

DISTRIBUTION. South-eastern Qld — from the Conondale Ra. region: Conondale SF & NP, at Booloumbah Ck; and Stony Ck SF, at Stony Ck.

REMARKS. This species reaches a large size and has a large and robust cirrus. The unspined distal region has very thick walls and in some cirrus preparations appears like a semicircular cap covering the spined region of the introvert.

Temnohaswellia pearsoni sp. nov.
(Fig. 13A–E)

ETYMOLOGY. For Steve Pearson who as head ranger at Eungella NP in 1990 assisted LRGC and KBS to locate and collect the host from which the first specimen was recognised.

MATERIAL. HOLOTYPE: QMG220279 (WM), from *Euastacus eungella* [QMW26610], Cattle Ck trib., 1.5 km SE Mt William, Eungella NP, Qld (21°01.8'S, 148°36.2'E), 22.09.1990, L.R.G. Cannon & K.B. Sewell, Form/Un. PARATYPES: QMG220280–220281 (WM), Form/Un: QMG220282–220283 (WM), HW/Form-Acetic/Hx. OTHER MATERIAL FROM TYPE LOCALITY: QMG220284–220285 (WM), Carn/Hx; QMG220286–220287 (WM), HW/Form-Acetic/Hx; QMG220288–220289 (WM)., Form/Un; QMG220290–220294 (CP), Form/Fau; [QMW26609], QMG220295–220296 (CP), 8.09.2002, D. Blair & D. Hansman, 100% alc/Fau.

DESCRIPTION. Characteristics of genus but lacking body pigment and (apparently) eyes. Selected body measurements of type specimens from *Euastacus eungella* are: QMG220279 (H): B(1894 × 740), LE(na), PH (260 × 455), SD(301), PD(130); QMG220280 (P): B(1897 × 755), LE(na), PH (306 × 449), SD(326), PD(143); QMG220281 (P): B(1897 × 918), LE(na), PH (326 × 530), SD(367), PD(184); QMG220282 (P): B(1350 × 545), LE(na), PH (195 × 268), SD(236), PD(130); QMG220283 (P): B(1795 × 959), LE(na), PH (306 × 510), SD(347), PD(224).

Reproductive system. Female. Vagina: Outer region with rounded teeth arranged in columns (6?) and rows (6?).

Male. Cirrus: Shaft cone-shaped. Introvert cylinder-shaped; distal opening transverse. Unspined distal region about as long as introvert longer side. Swelling even, extending proximally just past introvert base on both sides. Selected cirrus measurements of specimens from *Euastacus eungella* from type locality are: QMG220290: S(161 × 47), I(55 × 16), U(43), IS(na × na);

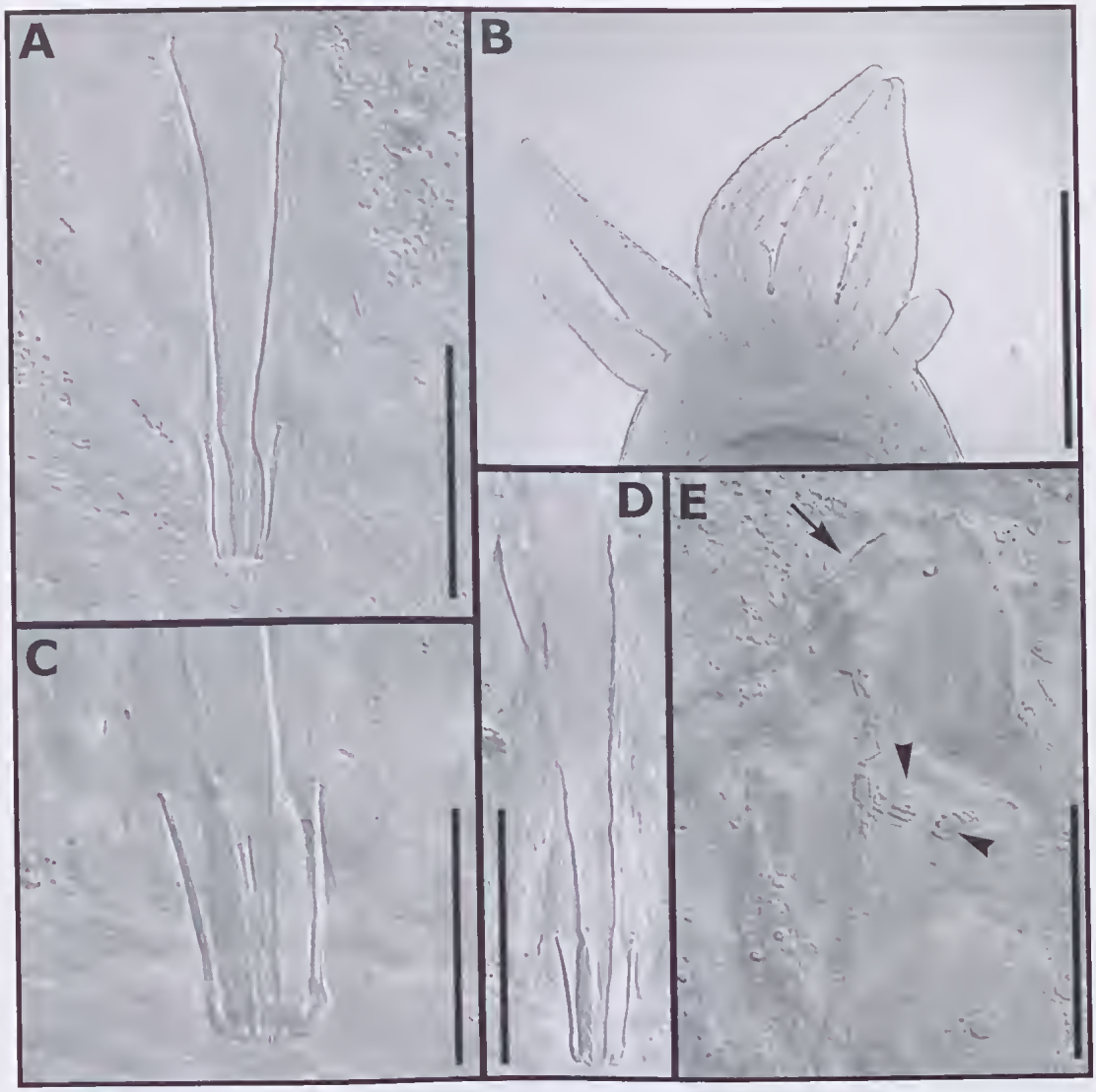


FIG. 13. *Temnohaswellia pearsoni* sp. nov. A, C–E, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220292, whole cirrus (stitched image), scale = 100μm; B, QMG220280, anterior end of wholemounted specimen showing the absence of eyes, scale = 500μm; C, QMG220291, introvert, scale = 50μm; D, QMG220290, whole cirrus, scale = 100μm; E, QMG220291, introvert (arrow) and vagina showing rounded teeth (arrowheads) in the outer region of the distal vagina, scale = 100μm.

QMG220291: S(152 × 47), I(49 × 15), U(47), lS(na × na); QMG220292: S(159 × 45), I(50 × 16), U(51), lS(14 × 10); QMG220295: S(165 × 35), I(46 × 14), U(39), lS(6 × 6); QMG220296: S(171 × 47), I(42 × 16), U(43), lS(8 × 5).

HOST. *Euastacus eungella*.

DISTRIBUTION. Mid-eastern Qld — from Eungella NP, SE Mt William, at upper Cattle Ck.

REMARKS. This species apparently lacks eyes, a character which separates it from all other known species of *Temnohaswellia*. Cannon & Sewell (2001) reported that occassional eyeless specimens of temnocephalans are encountered as a result of teratology. In this study, however, covering a large number of specimens and a wide range of hosts collected over broad spectrum of dates, we saw no obvious teratologies. Nevertheless, it is pertinent to note that in the

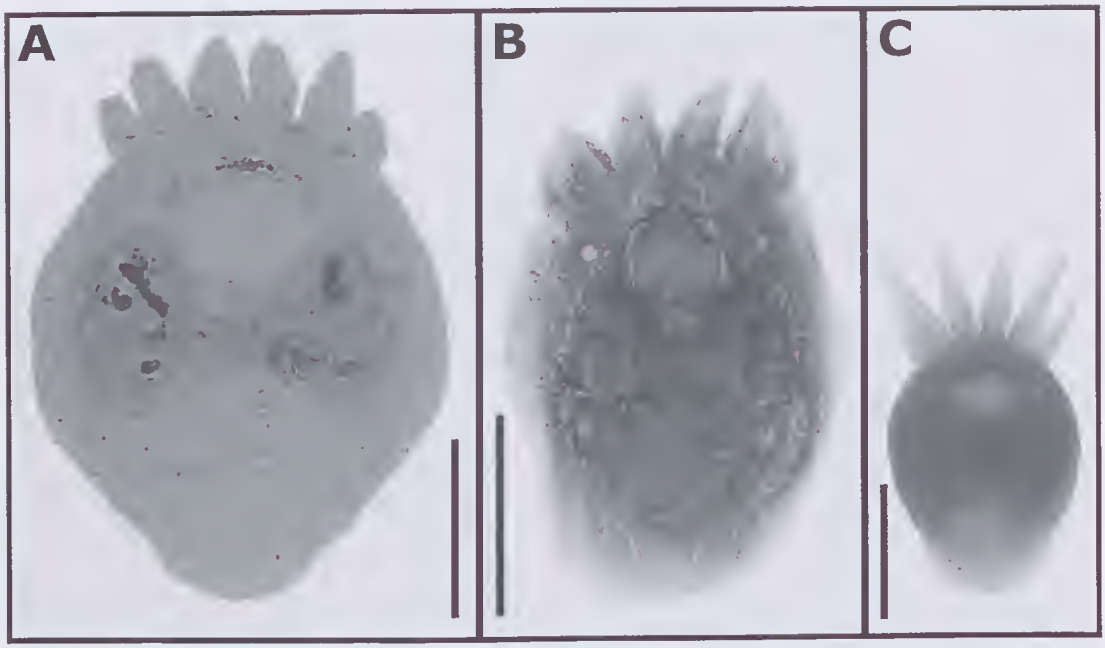


FIG. 14. *Temnohaswellia simulator*: A-C. Photomicrographs of whole specimens showing pigment variation between localities; A, QMG220067, Faures preparation of specimen (slightly compressed) from the locality showing no body pigment except that concentrated near eyes, scale = 1mm; B, QMG220199, wholemounted specimen from Whian Whian SF, NSW showing the dense tracery of body pigment through most of the dorsal body, scale = 1mm; C, QMG220075, small wholemounted specimen from Wollemi NP, NSW showing the dense tracery of body pigment through most of the dorsal body, scale = 500µm.

case of *Temnohaswellia pearsoni* sp. nov. only a single locality was sampled. It is worth noting too that *Temnohaswellia capricornia* sp. nov. from Kroombit Tops has very tiny eyes. These are the two most northerly species recorded in the genus.

All of the Australian temnocephalan species described previously known to either lack, or to have extremely small, eyes are, not surprisingly, from deep burrowing hosts that are presumed to rarely emerge during daylight (Haswell, 1893, 1900; Williams, 1980; Cannon & Sewell, 2001).

Damborenea & Cannon (2001) observed that the red pigment eyes of *Temnocephala* spp. from South America disappeared soon after placement in alcohol-based fixative. We can not exclude this phenomenon for *Temnohaswellia pearsoni* sp. nov., as live specimens were not examined for the presence of eyes.

The introvert is also distinctive, being armed with small, fine spines.

Temnohaswellia simulator (Haswell, 1924) (Figs 14A–C, 15A–G)

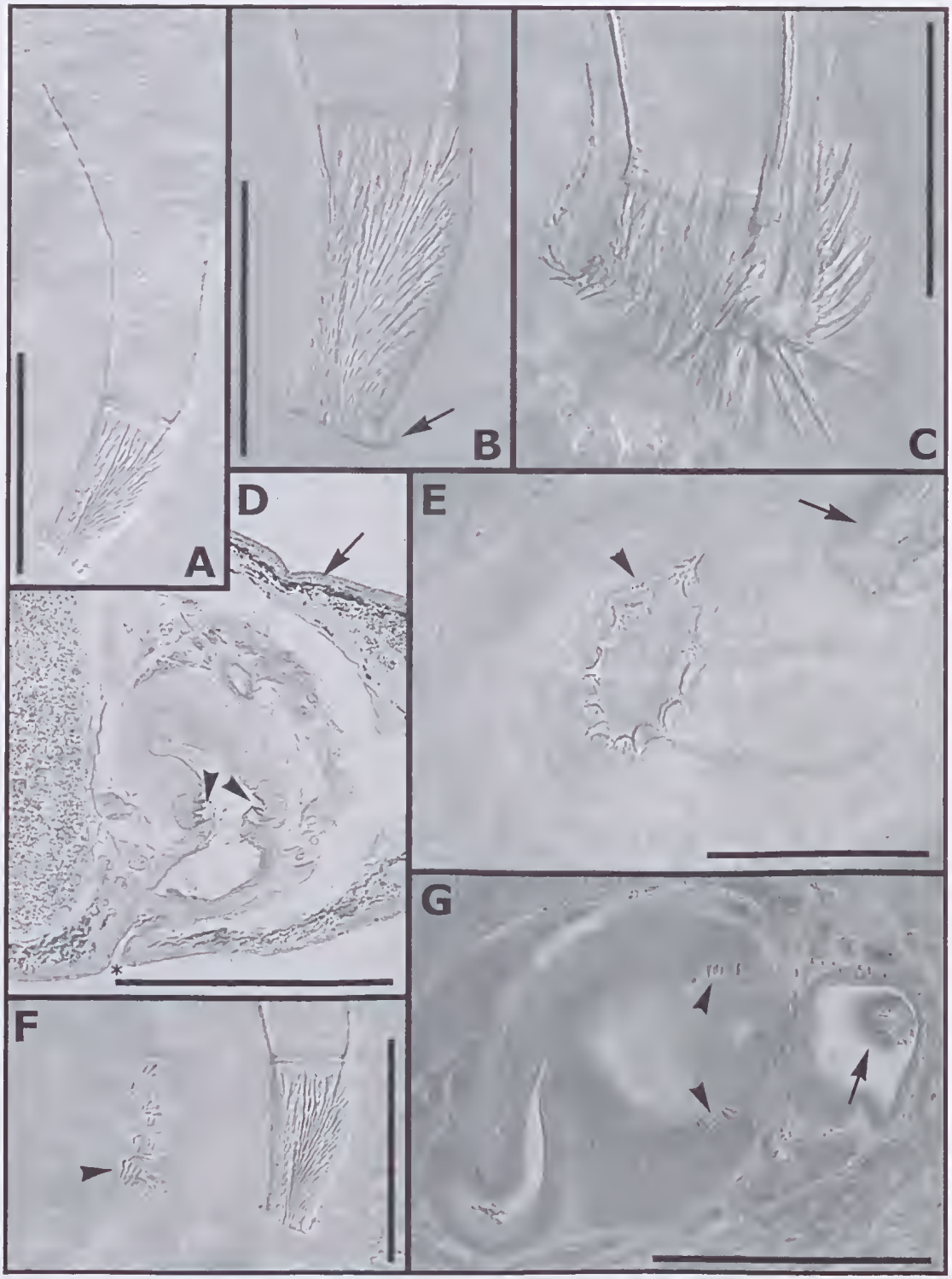
Temnocephala simulator Haswell, 1924: 512–513, pl. 55 fig 12, pl. 56 fig. 16

Temnohaswellia simulator Pereira & Cuocolo, 1941: 103.

Temnohaswellia tetrica Cannon, 1993: 31–33, fig. 8.

ETYMOLOGY. Haswell (1924) provided no derivation of the name. There can be little doubt that

FIG. 15. (opposite page) *Temnohaswellia simulator*: A-C, E-F, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220072, whole cirrus, scale = 100µm; B, QMG220072, introvert with short unspined distal region (arrow), scale = 50µm; C, QMG220071, introvert partly everted showing spines, scale = 50µm; D, QMG220194, longitudinal section through vagina showing teeth in the outer region of the distal vagina (arrowheads); dense pigment in the dorsal body (arrow); and the common gonopore (*), scale = 250µm; E, QMG220064, introvert (arrow) and vagina with teeth (arrowhead) in the outer region of the distal vagina showing the in a 'spider web' pattern, scale = 100µm; F, QMG220072, introvert and vagina with teeth (arrowhead) in the outer region of the distal vagina, scale = 50µm; G, QMG220174, longitudinal section showing teeth in the outer region of the distal vagina (arrowheads) and the distal region of the introvert (arrow), scale = 50µm.


A
B
C
D
E
F
G

it is from *simulator* = mimic (Latin); a reference to the similarity between *Temnohaswellia simulator* and *T. comes*. Haswell (1924) noted that both worms have six tentacles, and he stated that the entire reproductive system of *Temnohaswellia simulator* 'closely resembles' that of *T. comes*.

MATERIAL. NEOTYPE: From *Euastacus neohirsutus* [QMW26650], QMG220056 (WM), Middle Ck trib., beside road 6 km upstream from Corritts Water (30°21.4'S 152°29.1'E), 6.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26650], QMG220057–220058 (WM), hot Bouin/Un; [QMW26651], QMG220059–220060 (WM), 15.02.1992, K.B. Sewell & S.G. Sewell, HW/Form/Hx; [QMW26650], QMG220061–220061 (WM), 6.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; [QMW26651], QMG220063 (WM), 15.02.1992, K.B. Sewell & S.G. Sewell, HW/Form/Hx; [QMW26650], QMG220064 (CP), 6.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Fau; QMG220065–220071 (CP), Fau; [QMW26651], QMG220072 (CP) 15.02.1992, K.B. Sewell & S.G. Sewell; QMG220073–220074 (LS[3,2]), Bouin/H&E. OTHER MATERIAL. From *Euastacus armatus*? [juvenile]. NSW: [QMW26580], QMG220075–220078 (WM), Cudgegong R. at junction with Mill Ck, Wollemi NP (32°50.7'S 150°14.4'E), 20.10.1991, L.R.G. Cannon & K.B. Sewell Form/MB/Hx; QMG220079 (CP), Form/Fau; QMG220080 (LS[2]). Form/H&E.

From *Euastacus dangadi*. NSW: [QMW26605], QMG220081–220083 (WM), Eungai Ck trib., at Cedar Crossing, Ngaamba NR, Ingalba SF (30°53.9'S 152°47.3'E), 6.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; QMG220084–220085 (CP) 100% alc/Fau; QMG220086–220090 (CP), Fau.

From *Euastacus gumar*. NSW: [QMW26622], QMG220091–220094 (WM), Culmaron Ck, Richmond Ra. NP, (28°50.5'S 152°44.1'E), 4.03.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, 100% alc/Bouin/Un; QMG220095–220096 (CP), 100% alc/Fau; QMG220097 (CP), Fau.

From *Euastacus neohirsutus*. NSW: [QMW26638], QMG220141–220142 (WM), Little Nymboida R., junction of Lowamnna and Coramba Rds, Bindarri NP (30°14.0'S 152°55.3'E), 5.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; QMG220143–220144 (CP), 100% alc/Fau; [QMW26637]; QMG220145–220146 (CP), 15.02.1992, K.B. Sewell & S.G. Sewell, Bouin/Fau; QMG220147–220148 (LS[2,2]), Form/H&E.

From *Euastacus spinichelatus*. NSW: [QMW26652], QMG220157 (WM), Joyces Ck, Oxley Hwy crossing, 6km SE of Yarrowitch, Enfield SF, (31°16.7'S 151°58.3'E), 8.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; QMG220158 (WM), hot Bouin/Un; [QMW26653], QMG220159 (WM), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form; [QMW26652], QMG220160 (WM), 8.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; QMG220161–220162 (CP), 100% alc/Fau; QMG220163–220164 (CP), HW/Form/Fau.

From *Euastacus sulcatus*. Qld: [QMW26657], QMG220165 (WM), upper Tallebudgera Ck, at '1000m mark on main track' (28°14.0'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell; QMG220166–220167 (CP), 100% alc/Fau; [unreg. host, ident. Dr John Short, QM], QMG220168–220169 (CP), Mosses Well, Spicers Gap, Main Ra. NP (28°04.0'S 152°26.3'E), 25.11.1991, K.B. Sewell, Fau. NSW: [QMW26655], QMG220170 (WM). Bundoozle Flora Reserve, Richmond Ra. NP (28°36.4'S 152°42.1'E), 4.03.2002, K.B. Sewell, S.G. Sewell & Coughran J.A., 100% alc/Un.

From *Euastacus suttoni*. Qld: [QMW26660], QMG220171 (WM), beside rd to The Pyramids, Girraween NP (28°49.1S 151°58.8'E), 18.04.1990, S. Cook, Form-Acetic/Hx; QMG220172 (CP), Form-Acetic/Fau; QMG220174–220176 (LS[2,2,6]) Bouin/H&E. [QMW26663], QMG220177–220179 (WM), Washpool Ck, nr Thunderbolts Hideout, N of Tenterfield (28°58.4'S 152°04.4'E), 4.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; [QMW26662], QMG220180 (CP), Glen Innes, Dec. 1976, I. Kneipp, Fau.

From *Euastacus valentulus*. Qld: [QMW26666], QMG220186–220188 (WM), Tallebudgera Valley (28°08'S 153°26'S), D.J. Cook, 70% alc/Hx; QMG220189–220192 (CP), 70% alc/Fau, QMG220193–220195 (LS[1,1,2]), 70% alc/H&E. NSW: [QMW6459] QMG220196–220200 (WM), Rocky Ck rainforest, Whian Whian SF, (28°40'S 153°18'E), Jul. 1974, G.B. Monteith & S.R. Monteith., 70% alc/Hx; QMG220201–220207 (CP), 70% alc/Fau.

From *Caridina* sp. (*nilotica*?) (Crustacea; Decapoda; Atyidae) [spurious record, see remarks], Qld: [unreg. host] QMGL 14580 (WM), From *Caridina* sp. (*nilotica*?), Aplin Weir, on Ross R., Townsville, Qld (19°22'S 146°44'E), L. Winsor, Form/Picrocarmine.

DESCRIPTION. Characteristics of genus but across its range varies from having dense concentration of pigment around and between the eyes (as figured by Cannon, 1993: fig. 8b), through to dense tracery of pigment extending over dorsal body and tentacles. Selected body measurements of specimens from *Euastacus neohirsutus* from type locality are: QMG220056 (N): B(2448 × 1387), LE(1652), PH(367 × 551), SD(408), PD(265); QMG220057: B(2183 × 1489, LE(1469), SD(530), PH(408 × 612), PD(306); QMG220058: B(3040 × 1754), LE(2081), PH(469 × 632), SD(632), PD(347); QMG220059: B(1652 × 653), LE(959), PH(224 × 352), SD(265), PD(102); QMG220060: B(1897 × 775), LE(1122), PH(265 × 306), SD(347), PD(143).

TABLE 1. Description of body pigment for *Temnohaswellia simulator* collected from different *Euastacus* hosts.

Host	Body pigment description
Euastacus armatus? [juvenile]	Dense, fine tracery over most of dorsal body, extends past bases of tentacles, with thicker tracts concentrated around eyes.
E. dangadi	Concentrated around and between eyes.
E. gumar	Concentrated around and between eyes.
E. neohirsutus	Concentrated around and between eyes.
E. spinichelatus	Small concentration around and between eyes.
E. sulcatus	Small concentration around and between eyes.
E. suttoni	Concentrated around and between eyes and extending farther in larger worms.
E. valentulus	Dense, course tracery over most of dorsal body surface, extends past bases of tentacles, with very thick tracts radiating from near eyes.

Reproductive system. Female. Vagina: Outer region with teeth (when folds are sufficiently compressed [as in a concertina]), arranged in numerous (>10) columns and 6(?) rows. When viewed distally to proximally, folds form pattern reminiscent of spider's web.

Male. Cirrus: General form as figured by Cannon (1993: fig. 8d, 11h). Shaft cone-shaped. Introvert cylinder-shaped (as figured by Cannon 1993: fig.8d). Unspined distal region short, about one quarter length of introvert longer side. Swelling near even, extending proximally well past introvert base, slightly farther on longer side; distal opening slightly oblique. Selected cirrus measurements of specimens from *Euastacus neohirsutus* from type locality are: QMG220066: S(207 × 98), I(75 × 35), U(18), IS(102 × 72); QMG220068: S(238 × 100), I(71 × 33), U(18), IS(85 × 81); QMG220069: S(193 × 91), I(71 × 27), U(18), IS(100 × 61); QMG220072: S(205 × 81), I(79 × 35), U(18), IS(85 × 67).

HOSTS. *Euastacus armatus*?, *Euastacus dangadi, E. gumar, E. neohirsutus, E. spinichelatus, E. sulcatus, E. suttoni, E. valentulus.*

DISTRIBUTION. South-eastern Qld to south-eastern NSW widespread along the Great Dividing Ra.

REMARKS. Neither type specimens of *Temnohaswellia simulator* nor specimens assigned to this species by Haswell were located. Nevertheless, the specimens we describe here conform essentially to the incomplete and informal description of *Temnohaswellia simulator* by Haswell (1924: page 513, footnote). In particular, the presence of body pigment and the form of the female reproductive system, we believe, confirm the validity of the species. *Temnohaswellia simulator* was described by Haswell (1924) from specimens removed from crayfish collected from Barrengarry Ck, above Belmore Falls. We did not find *Temnohaswellia simulator* in the Belmore Falls region, although we do report *T. comes* and describe *T. verruca* sp. nov. from the locality of Burrawang Ck, a close tributary of Barrengarry Ck.

There is, however, little chance that Haswell (1924) confused either of these two species with *Temnohaswellia simulator* as both lack body pigment.

Haswell (1924) stated that *Temnohaswellia simulator* had papillae near the distal opening of the vagina that 'assume the appearance of rudimentary teeth', a character he recognised as absent from *T. comes*. We observed that the outer vagina of *Temnohaswellia simulator* has distinctive sclerotised folds that appear as teeth and which are most clearly observed in sections (Fig. 15D, G).

Temnohaswellia simulator is the only Australian species of *Temnohaswellia* we encountered to have body pigment. Not all hosts, however, had worms with extensive body pigment, although all worms had a concentration of pigment around and between the eyes (Table 1).

Heavily pigmented specimens, i.e. those on *Euastacus armatus* from Wollemi NP and on *E. valentulus* from Tallebudgera Valley and Whian Whian SF, were otherwise morphologically indistinguishable from specimens from other hosts and localities across its range. The degree of body pigmentation does not appear to be related to the size (= age?) of the worms, except within populations collected from the same host

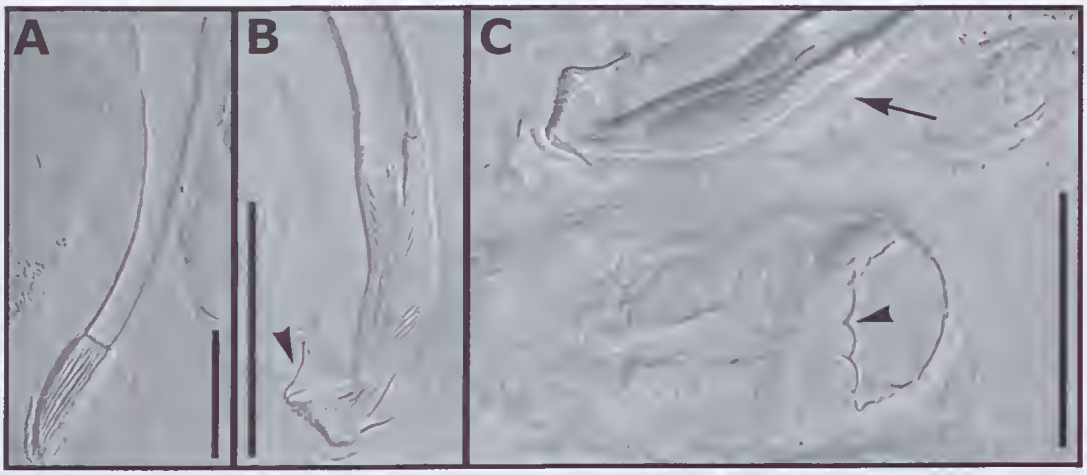


FIG. 16. *Temnohaswellia subulata* sp. nov. A–C. Nomarski interference contrast photomierographs of Faure's preparations; A, QMG220308, whole cirrus with partially everted introvert (stitched image), scale = 100µm; B, QMG220311, introvert showing short unspined distal region (arrowhead), scale = 100µm; C, QMG220311, introvert (arrow) and vagina showing weak sclerotisation in the distal region (arrowhead), scale = 100µm.

at the same locality. For example, large worms from the type locality had slightly more pigment than smaller worms, but much less pigmentation than small worms from Wollemi NP.

The widespread distribution of *Temnohaswellia simulator* may result in some variation in body size and form between localities and hosts, including the degree of body pigment. Since nomenclatural instability could potentially develop, a neotype has been designated from near the approximate centre of the distribution recorded in this study.

Included here is the pigmented specimen that Cannon (1993) described as *Temnohaswellia tetrica* from a single holotype wholemounted specimen reputedly collected from the freshwater shrimp, *Caridina* sp. (*nilotica*?) at Townsville, Qld. We have examined the holotype of *Temnohaswellia tetrica* and consider that the specimen is *T. simulator*. For the same reasons as stated previously for *Temnohaswellia pugna* we believe that the determination of a shrimp host is an error, and that the specimen was probably from the crayfish host *Euastacus suttoni* [QMW26662], collected at Glen Innes, NSW.

Temnohaswellia subulata sp. nov.
(Fig. 16A–C)

ETYMOLOGY. From *subula* = awl (Latin); a reference to the relatively straight, even taper of the cirrus.

MATERIAL. HOLOTYPE: QMG220297 (WM), from *Euastacus australasiensis* (juvenile) [QMW26583], Govetts Leap Brook, James St crossing on Braeside Walk, Blackheath, Blue Mts NP, NSW (33°38.5'S 150°18.4'E), 20.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx. PARATYPES: QMG220298–220301 (WM), HW/Form/Hx. OTHER MATERIAL FROM TYPE LOCALITY: QMG220302–220306 (WM), HW/Form/Hx; [QMW26644], QMG220307 (WM), 12.02.2002, K.B. Sewell & R.D. Sewell, 100% ale/Un; QMG220308–220309 (CP), 100% ale/Un; [QMW26583], QMG220310–220313 (CP) 20.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Fau; [QMW27496], QMG221205–221206 (CP), 2.01.2004, D. Blair & R.D. Sewell, alc/Fau.

DESCRIPTION. Characteristics of genus but lacking body pigment except for occasionally thinly scattered pigment between the eyes. Selected body measurements of type specimens from *Euastacus australasiensis* are: QMG220297 (H): B(1659 × 805), LE(976), PH (252 × 333), SD(341), PD(138); QMG220298 (P): B(1967 × 959), LE(1138), PH (268 × 358), SD(390), PD(203); QMG220299 (P): B(1593 × 837), LE(967), PH (203 × 366), SD(366), PD(146); QMG220300 (P): B(1707 × 854), LE(1008), PH (236 × 366), SD(370), PD(163); QMG220301 (P): B(1496 × 699), LE(894), PH (244 × 317), SD(325), PD(146).

Reproductive system. Female. Vagina: Outer region weakly sclerotised, lacking teeth.

Male. Cirrus: Shaft cone-shaped. Introvert cylinder-shaped; distal opening not obviously oblique. Unspined distal region short, about one fifth length of introvert longer side. Swelling even, extending proximally just past introvert base on both sides, slightly farther on longer side. Selected cirrus measurements of specimens from *Euastacus australasiensis* from type locality are: QMG220308: S (280 × 69), I(126 × 24), U(24), IS(8 × 4); QMG220309: S (270 × 63), I(135 × 30); U(26), IS(10 × 4); QMG220311: S (248 × 59), I(137 × 26); U(26), IS(6 × 2); QMG220312: S (270 × 67), I(124 × 26); U(26), IS(8 × 3); QMG220313: S (250 × 69), I(126 × 28), U(26), IS(12 × 4).

HOST. *Euastacus australasiensis.*

DISTRIBUTION. Mid-eastern NSW — from the Blue Mountains NP, near Blackheath at Govetts Leap Brook.

REMARKS. The long thin awl-like cirrus is quite characteristic and unlike any other *Temnohaswellia* observed. This worm was not found to co-occur with other species of *Temnohaswellia* on the host from which it was collected.

Temnohaswellia umbella sp. nov.
(Fig. 17A–E)

ETYMOLOGY. From *umbella* = parasol (Latin); a reference to the unspined distal region of the introvert in appearance like a long folded parasol.

MATERIAL. HOLOTYPE: from *Euastacus guwinus* (c.f. *dharawalus*) [QMW26624], QMG220261 (WM), Tianjarra Ck, above Tianjarra Falls, Morton NP (35°06.7'S 150°19.8'E), 18.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx. PARATYPES: QMG220262–220264 (WM), HW/Form/Hx; [QMW26623], QMG220265 (WM), 18/2/2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26624], QMG220266 (WM), 18.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG220267–220271 (CP), 100% ale/Fau; QMG220272 (CP), Fau; [QMW26625], QMG220275 (CP), 13.02.2002, K.B. Sewell & R.D. Sewell, 100% ale/Fau; [QMW26624], QMG220276–220277 (LS[1,2]), 18.10.1991, L.R.G. Cannon & K.B. Sewell, Form/H&E; QMG220278 (LS[2]), HW/Form/H&E.

DESCRIPTION. Characteristics of genus but lacking body pigment except for occasionally thinly scattered pigment between the eyes. Selected body measurements of type specimens from *Euastacus guwinus* are: QMG220261 (H): B(1836 × 938), LE(1122), PH(224 × 357), SD(347), PD(173); QMG220262 (P): B(1836 × 918), LE(1122), PH(275 × 347), SD(367), PD(184); QMG220263 (P): B(1897 × 928), LE(1040), PH(245 × 347), SD(367), PD(184); QMG220264 (P): B(1142 × 592), LE(857), PH(143 × 224), SD(235), PD(102); QMG220265 (P): B(1428 × 1020), LE(1000), PH(224 × 347), SD(326), PD(194).

Reproductive system. Female. Vagina: Outer region with blunt, comb-like teeth increasingly larger and more plate-like proximally, arranged in columns (6?) and rows (12?).

Male. Cirrus: Shaft cone-shaped. Introvert cylinder shaped; distal opening not obviously oblique. Unspined distal region very long and thin, nearly twice length of spined region on longer side, with prominent folds oriented parallel to long axis of introvert. Distal extremity of unspined region appears ruffled in appearance, analogous to rim of folded umbrella. Swelling not observed [obscured by unspined region of introvert]. Selected cirrus measurements of specimens from *Euastacus guwinus* (c.f. *dharawalus*) from type locality are: QMG220267: S(331 × 93), I(112 × 24), U(215), IS(na × na); QMG220268: S(409 × 122), I(132 × 28), U(234), IS(na × na); QMG220269: S(327 × 89), I(138 × 28), U(217), IS(na × na); QMG220270: S(346 × 89), I(136 × 26), U(234), IS(na × na); QMG220275: S(356 × 126), I(124 × 26), U(222), IS(na × na).

HOST. *Euastacus guwinus* (c.f. *dharawalus*).

DISTRIBUTION. Mid-eastern NSW — from W of Nowra, Morton NP, at Tianjarra Falls.

REMARKS. The cirrus and vagina of this species resemble most closely those of *Temnohaswellia breviumbella* sp. nov. The introvert, however, is longer, particularly the unspined distal region of the introvert which is about twice the length of that of *Temnohaswellia breviumbella* sp. nov. The function of the large unspined region is unknown.

Temnohaswellia verruca sp. nov.
(Fig. 18A–G)

ETYMOLOGY. From *verruca* = wart (Latin, feminine); a reference to the six wart-like sclerotised protruberences [cusp-like teeth] at the distal opening of the vagina.

MATERIAL. HOLOTYPE: QMG219548 (WM), from *Euastacus claytoni,* [QMW26599], Lowden Ck, in Lowden FP picnic area, Tallaganda SF, NSW (35°30.8'S 149°36.2'E), 17.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Un. PARATYPES:

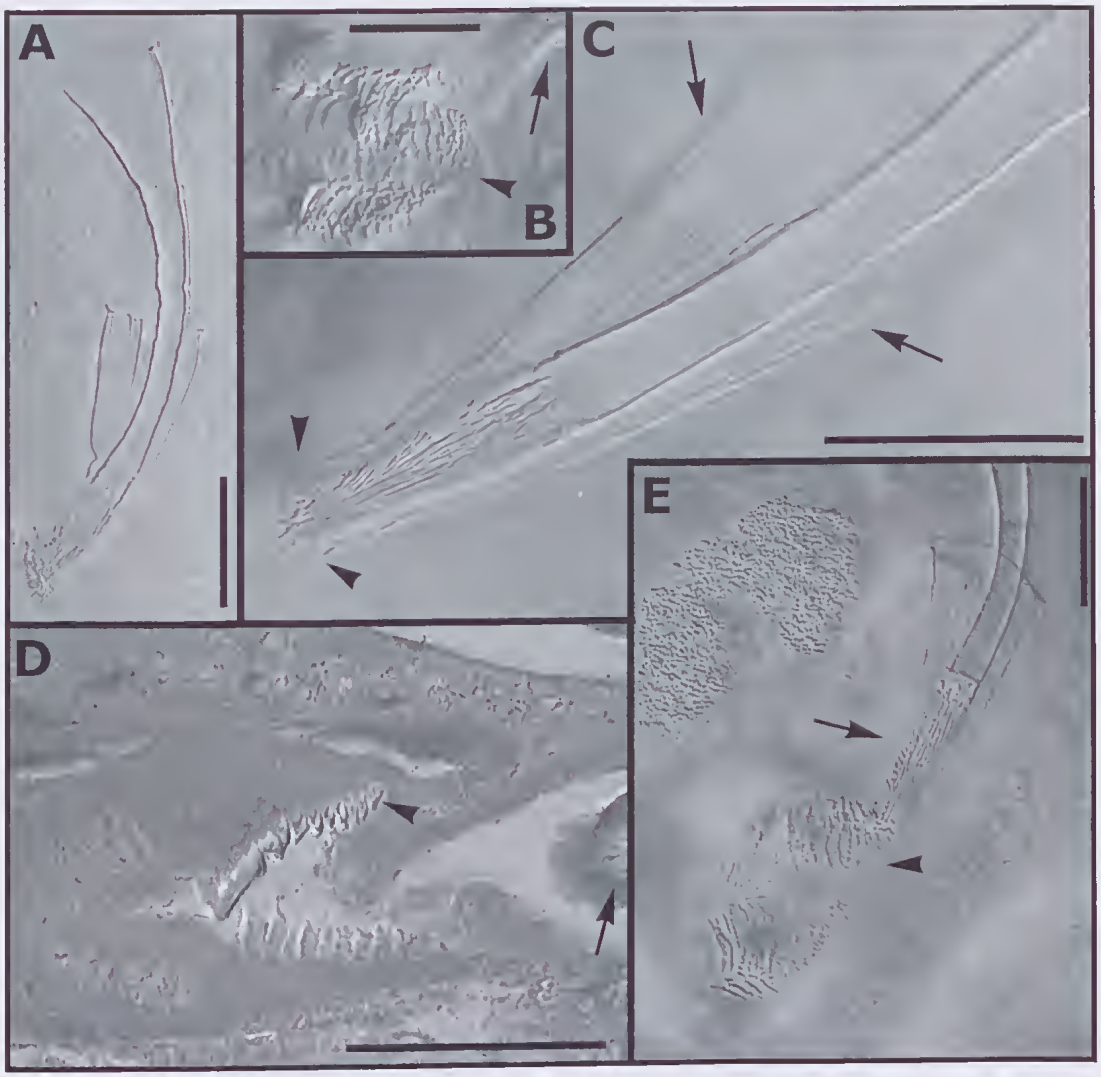


FIG. 17. *Temnohaswellia umbella* sp. nov. A–C, E. Nomarski interferenee contrast photomierographs of Faure's preparations. A, QMG220270, eirrus, seale = 100µm; B, QMG220275, introvert (arrow) and vagina with rows of eomb-like teeth in the distal region (arrowhead), seale = 100µm; C, QMG220268, introvert showing the long unspined distal region (arrows), the distal extremity of the introvert spined region is indieated by arrowheads, seale = 100µm; D, QMG220278, longitudinal seetion showing teeth in the outer region of the distal vagina (arrowhead) and the distal region of the introvert (arrow), scale = 50µm; E, QMG220275, vagina showing rows of eomb-like teeth in the distal region (arrowhead) that inerease in size proximally and the introvert (arrow), seale = 100µm.

QMG219549 (WM), QMG219550 (WM), HW/Form/Hx; [QMW26600], QMG219551–219552 (WM), 16.02.2002, K.B. Sewell & R.D. Sewell, 70% Alc/Un). OTHER MATERIAL FROM TYPE LOCALITY: QMG219553 (WM); [QMW26644], QMG219554 (LS [3]), 17.10.1991, L.R.G. Cannon & K.B. Sewell, Form/H&E; QMG219555 (LS [2]); [QMW26600], QMG219556 (CP), 16.02.2002, K.B. Sewell & R.D. Sewell, 100% ale/Fau; QMG219557–219561 (CP); [QMW26644], QMG219562–219563 (CP), 17.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Fau. OTHER MATERIAL. From *Euastacus armatus*. VIC: [unreg. host, ident. Dr Susan Lawler, Latrobe University, VIC], QMG219564–219565 (CP), Yackandandah Ck, (36°14'S 146°57'S), 20.11.2001, S.H. Lawler & G.N. Edney; [QMW26582], QMG219566–219570 (WM), Buffalo R., Shultz Traek, 36km S of Buffalo (36°59.5'S 146°48.0'E),

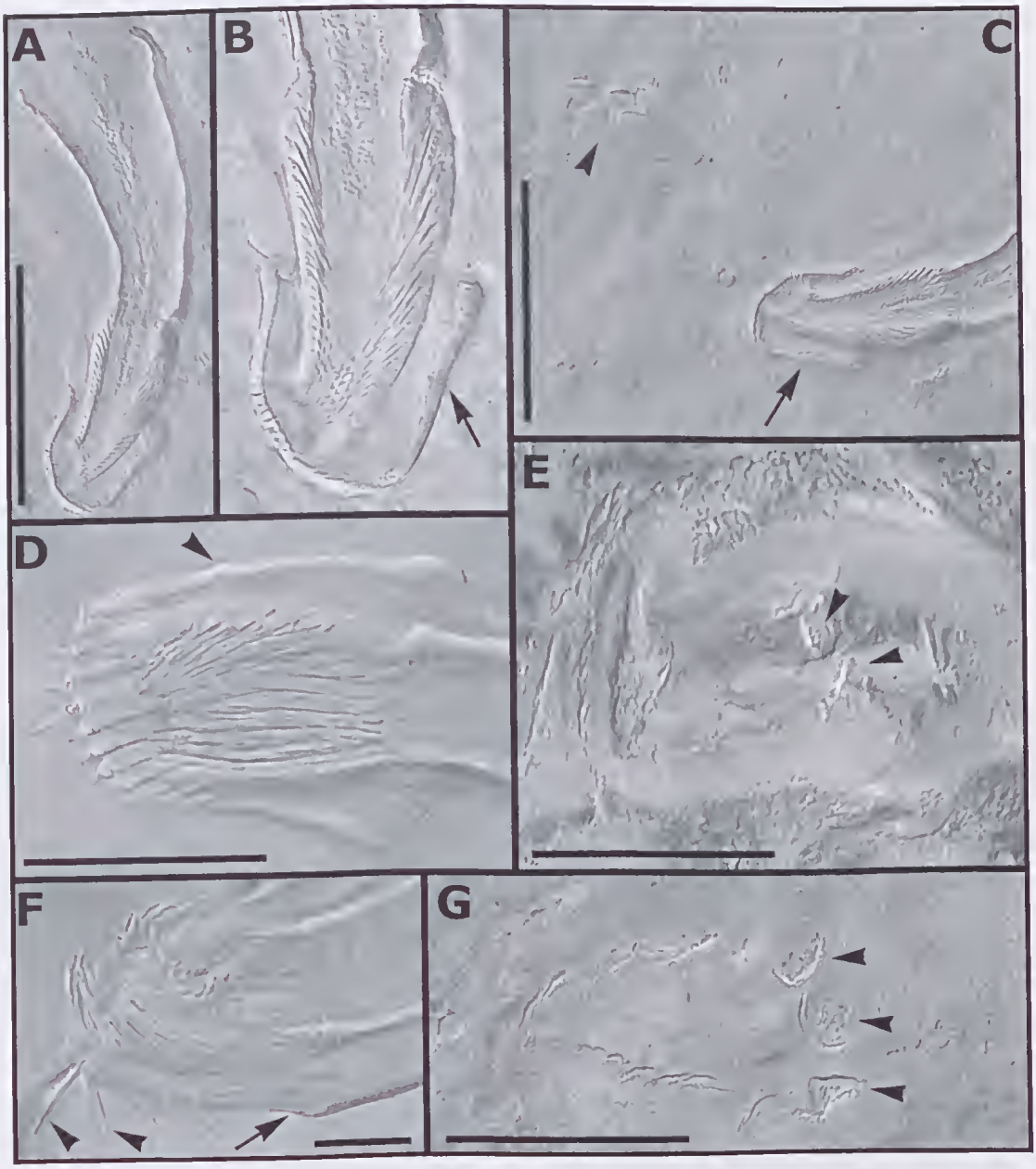


FIG. 18. *Temnohaswellia verruca* sp. nov. A-D, F-G, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG219578, cirrus, scale = 100µm; B, QMG220578, introvert showing unspined distal region (arrow), scale = 50µm; C, QMG219578, introvert (arrow) and vagina with cusp-like teeth in the outer region of the distal vagina (arrowheads), scale = 100µm; D, QMG219556, introvert showing the junction (arrowhead) between the spined region and unspined distal regions, scale = 50µm; E, QMG219554, longitudinal section showing cusp-like teeth in the outer region of the distal vagina (arrowheads), scale = 50µm; F, QMG219559, introvert partially everted showing long spines in the spined region (arrowheads) and the junction (arrow) between the spined region and unspined distal regions, scale = 20µm; G, QMG219558, vagina showing cusp-like teeth in the outer region of the distal vagina (arrowheads), scale = 50µm.

10.03.2002, G.N. Edney, 100% alc/Un; QMG219571–219577 (CP), 100% alc/Fau.

From *Euastacus bidawalus*. VIC: [QMW26588], QMG219578–219583 (WM), Dingo Ck, crossing on Euchre Valley Drive, Lind NP (37°34.7'S 148°58.2'E), 20.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un; QMG219584–219586 (CP) 100% alc/Fau; [unreg. host ident. Dr Sue Lawler, Latrobe University, VIC], QMG219587–219589 (CP), 3.01.1997, Lawler S.H., 100% alc/Fau; [QMW27482], QMG221207 (CP), 5.01.2004, D. Blair, R.D. Sewell, S.H. Lawler & G.N. Edney, alc/Fau.

From *Euastacus brachythorax*. NSW: [QMW26593], QMG219590–219592 (CP), Rutherford Ck crossing on Niten Rd, Brown Mtnn, Glenbog SF (36°36.4'S 149°24.4'E), 18.03.2002, K.B. Sewell, 100% alc/Fau.

From *Euastacus crassus*. ACT: [QMW26603], QMG219593 (WM), Kangaroo Ck, rd crossing above Corin Dam, Namadgi NP (35°32.3'S 148°52.2'E), 16.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Un; QMG219594–219597 (CP), HW/Form/Fau. VIC: [QMW26601], QMG219598–219600 (WM), Buchan R. in Native Dog Flat camping ground, Alpine NP (36°53.9'S 148°05.3'E), 19.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un; QMG219601–219603 (CP), 100% alc/Fau.

From *Euastacus dharawalus*. NSW: [QMW26607] QMG219604–219605 (WM), Wildes Meadow Ck crossing on Wildes Meadow Rd, Wildes Meadow (34°36.4'S 150°31.1'E), 13.02.2002, K.B. Sewell & R.D. Sewell, Bouin/Un; QMG219606 (WM), 70% alc/Un; QMG219607 (CP), 100% alc/Fau; QMG219608–219609 (CP), Fau.

From *Euastacus gamilaroi*. NSW: [QMW26620], QMG219610–219612 (WM), Burrows Ck, Sheeba Dams Recreation Reserve, near Hanging Rock (31°30.0'S 151°11.9'E), 22.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG219613–219614 (WM), HW/Form/Un; QMG219615–219620 (WM), HW/Form/Hx; QMG219621–219622 (WM), HW/Form/Un; [QMW26621], QMG219623–219625 (WM), 8.02.2002, K.B. Sewell & R.D. Sewell, Bouin/Un; QMG219626 (CP) 100% alc/Fau; QMG219627–219633 (CP), Fau.

From *Euastacus polysetosus*. NSW: [QMW26641], QMG219635–219637 (WM), Dilgry R., at Dilgry River Picnic Area, Barrington Tops NP (31°53.6'S 151°31.3'E), 21.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26640], QMG219638–219639 (WM), 9.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; [QMW26641], QMG219640–219644 (WM), 21.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG219645 (LS[2]), Form/H&E; QMG219646–219651 (CP) HW/Form/Fau; [QMW26640], QMG219652–219654 (CP), 9.02.2002, K.B. Sewell & R.D. Sewell, Fau; QMG219655–219659 (CP), 100% alc/Fau.

From *Euastacus reductus*. [QMW27488], QMG221209 (CP), Problem Ck crossing on Frying Pan Rd, trib. of Telegherry R., Chichester SF, 1km E of Telegherry FP NSW 32°13.6'S 151°45.8', 9.01.2004, D. Blair & R.D. Sewell, alc/Fau.

From *Euastacus spinifer*. [QMW27486], QMG221208 (CP), Piles Ck trib., beside the Great North Walk, Brisbane Waters NP NSW 33°26.2'E 151°16.4'E, 8.01.2004, D. Blair & R.D. Sewell, alc/Fau.

From *Euastacus yanga*. NSW: [QMW26627], QMG219634 (WM), Burrawang Ck at road crossing, 3km NW Belmore Falls, Morton NP (34°37.1'S 150°32.5'E), 19.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26671], QMG219660–219662 (WM), Monga NP, 2.7km along River Rd from Braidwood Rd junction (35°33.8'S 149°55.0'E), 16.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; [QMW26672], QMG219663–19665 (WM), 17.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26671], QMG219666 (WM), 16.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; QMG219667–219672 (CP), 100% alc/Fau.

From *Euastacus yarraensis*. VIC: [QMW26674], QMG219673 (WM), SF nr Cockatoo beside road in picnic area (37°56.6'S 145°29.6'E 145°29.6'E), 21.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un; QMG219674 (CP), 100% alc/Fau.

DESCRIPTION. Charaeteristies of genus but laeking body pigment exeept for oeeasionally thinly seattered pigment between the eyes. Seleeted body measurements of type speeimens from *Euastacus claytoni* are: QMG219548 (H): B(3182 × 1387), LE(2203), PH(652 × 591), SD(612), PD(286); QMG219549 (P): B(3060 × 1510), LE(2040), PH(530 × 714), SD(612), PD(326); QMG219550 (P): B(2591 × 1142), LE(1754), PH(469 × 612), SD(428), PD(245); QMG219551 (P): B(1836 × 959), LE(1326), PH(408 × 408), SD(428), PD(224); QMG219552 (P): B(1632 × 857), LE(1285), PH(338 × 367), SD(408), PD(235).

Reproductive System. Female. Vagina. Outer region with single row of eusp-like teeth, usually 6 seen.

Male. Cirrus. Shaft cone-shaped. Introvert eylinder to seoop shaped; distal opening oblique. Unspined distal region slightly more than half length of introvert longer side. Swelling uneven, extends proximally well past introvert base on both sides, farther on longer side. Seleeted eirrus measurements of speeimens from *Euastacus claytoni* from type loeality are: QMG219556: S(193 × 91), I(91 × 30), U(51), IS(110 ×

TABLE 2. *Temnosewellia* species from hosts other than *Euastacus*. Listed alphabetically by species of *Temnosewellia*. Data obtained from original species descriptions and from reviews in Cannon (1991), Cannon & Sewell (2001) and Damborenea & Cannon (2001).

Name and authority	Host genus	Country
Temnosewellia athertonensis (Cannon, 1993)	*Holthuisana*	Australia
Temnosewellia butlerae (Cannon, 1993)	*Holthuisana*	Australia
Temnosewellia caeca (Haswell, 1900)	*Phreatoicopsis*	Australia
Temnosewellia chaerapsis (Hett, 1925)	*Cherax*	Australia
Temnosewellia cita (Hickman, 1967)	*Parastacoides*	Australia
Temnosewellia dendyi (Haswell, 1893)	*Cherax*	Australia
Temnosewellia engaei (Haswell, 1893)	*Engaeus*	Australia
Temnosewellia geonoma (Williams, 1980)	*Phreatoicopsis*	Australia
Temnosewellia improcera (Cannon, 1993)	*Caridina*	Australia
Temnosewellia minor (Haswell, 1888)	*Cherax*	Australia
Temnosewellia minuta (Cannon, 1993)	*Paratya*	Australia
Temnosewellia neqae (Cannon, 1993)	*Macrobrachium*	Australia
Temnosewellia queenslandensis (Cannon, 1993)	*Macrobrachium*	Australia
Temnosewellia rouxii (Merton, 1913)	*Cherax*	Australia & Aru Islands
Temnosewellia semperi (Weber, 1890)	*Cherax*	SE Asia — from Indonesia to India
Temnosewellia acirra (Cannon & Sewell, 2001)	*Cherax*	Australia
Temnosewellia christineae (Cannon & Sewell, 2001)	*Cherax*	Australia
Temnosewellia punctata (Cannon & Sewell, 2001)	*Cherax*	Australia
Temnosewellia phantasmella (Cannon & Sewell, 2001)	*Cherax*	Australia

61); QMG219557: S(228 × 79), I(100 × 30), U(57), IS(na × na); QMG219558: S(128 × 55), I(91 × 26), U(51), IS(na × na); QMG219559: S(213 × 81), I(89 × 28), U(53), IS(108 × 73); QMG219560: S(219 × 77), I(91 × 26), U(51), IS(102 × 73).

HOSTS. *Euastacus armatus, E. bidawalus, E brachythorax, E. claytoni, E. crassus, E. dharawalus, E. gamilaroi, E. polysetosus, E. reductus, E. spinifer, E. yanga, E. yarraensis.*

DISTRIBUTION. Mid-eastern NSW to south-eastern VIC — widespread along the Great Dividing Ra.

REMARKS. The prominent sclerotised cusp-like teeth that ring the distal opening of the vagina of this species serve effectively to discriminate this species from *Temnohaswellia comes*, a worm of similar size and colour that co-occurs on several host species. Although there are considerable differences in the form of the cirrus introvert between these two species, they can, however, be somewhat disguised in wholemounted specimens, particularly if the introvert is compressed as a consequence of fixation. In such wholemounted specimens of *Temnohaswellia comes* the diagnostic large spines on the introvert base may be obscured. The unspined distal region has thick walls and in some cirrus preparations appears like a semicircular cap covering the spined region of the introvert.

Temnohaswellia sp.

MATERIAL. From *Euastacus urospinosus*. Qld: [QMW26665], QMG220182 (CP), Kondalilla Falls NP, at first creek from park entrance along walking track (26°41'S 152°52'E), 28.03.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG220183–220185 (LS[1,1,1]), HW/Form/Fau.

DESCRIPTION. Characteristics of genus but lacking body pigment.

REMARKS. This species appears close to *Temnohaswellia simulator* in the general form of the vagina and cirrus. Nevertheless, in the absence of additional specimens we are reluctant to describe this species formally.

Temnosewellia Damborenea & Cannon, 2001

Temnosewellia Damborenea & Cannon, 2001: 1115–1116.

TYPE SPECIES. *Temnocephala minor* Haswell, 1888, by original designation of Damborenea & Cannon, 2001. Gender is feminine. Host: *Cherax destructor* Clark, 1936.

DIAGNOSIS. Temnocephalinae reaching to c.10mm in length, five anterior tentacles and posterior pedunculate adhesive disc present; conspicuous papillate ridges or imbricating scales absent from tentacles or dorsal body; single dorsal pair of brown to dark brown pigmented eyes at base of tentacles; brown to dark-brown (melanin?) pigment (if present) in body. Gut appears dark. Vaginal cavity weakly sclerotised. Testes two pairs postero-lateral to gut; vasa deferentia enter seminal vesicle separately; ejaculatory sac semi-discrete.

Epidermal Mosaic (based on *Temnosewellia cypellum* sp. nov.). Epidermis composed of 5 syncytia: 1, tentacular; 2, a single, characteristically saddle-shaped post-tentacular plate; 3, body; 4, peduncular (stalk); and 5, adhesive disc. Post-tentacular syncytium anterior to nephridiopores which dorsally are contained in body syncytium (Fig. 38). Shallow groove marks border between dorsal and ventral surfaces along lateral margins of body and peduncular syncytia.

AUSTRALIAN SPECIES KNOWN FROM *EUASTACUS*

Temnosewellia acicularis sp. nov.
Temnosewellia alba sp. nov.
Temnosewellia albata sp. nov.
Temnosewellia aphyodes sp. nov.
Temnosewellia apiculus sp. nov.
Temnosewellia arga sp. nov.
Temnosewellia argeta sp. nov.
Temnosewellia argilla sp. nov.
Temnosewellia aspinosa sp. nov.
Temnosewellia aspra sp. nov.
Temnosewellia bacrio sp. nov.
Temnosewellia bacrioniculus sp. nov.
Temnosewellia batiola sp. nov.
Temnosewellia belone sp. nov.
Temnosewellia caliculus sp. nov.
Temnosewellia cestus sp. nov.
Temnosewellia comythus sp. nov.
Temnosewellia coughrani sp. nov.
Temnosewellia cypellum sp. nov.
Temnosewellia fasciata (Haswell, 1888)
Temnosewellia fax sp. nov.
Temnosewellia flammula sp. nov.
Temnosewellia gingrina sp. nov.
Temnosewellia gracilis sp. nov.
Temnosewellia keras sp. nov.
Temnosewellia maculata sp. nov.
Temnosewellia magna sp. nov.
Temnosewellia maxima sp. nov.
Temnosewellia minima sp. nov.
Temnosewellia muscalingulata sp. nov.
Temnosewellia possibilitas sp. nov.
Temnosewellia unguiculus sp. nov.
Temnosewellia sp.

REMARKS

The present paper deals only with *Temnosewellia* from Australian *Euastacus* hosts. *Temnosewellia* are, however, recorded from other crustacean hosts within and outside Australia (Table 2).

KEY TO SPECIES OF *TEMNOSEWELLIA* (FROM AUSTRALIAN *EUASTACUS* SPP. CRAYFISH)

1. Body pigment present (some specimens, especially juveniles, can have little pigment*) 2
   Lacking body pigment. 3
2. Body pigment punctate (sometimes not pronounced*) 9
   Body pigment fine and evenly distributed. 12
3. Cirrus introvert base (normally < 15µm wide)..... 4
   Cirrus introvert base (normally > 15µm wide) 6
4. Cirrus introvert swelling (IS) short along both sides of shaft ..... *T. aphyodes* sp. nov.
   Cirrus introvert swelling (IS) long along both sides of shaft 5
5. Cirrus introvert opening oblique..... *T. argeta* sp. nov.
   Cirrus introvert opening very oblique.. *T. aspra* sp. nov.
6. Cirrus introvert swelling (IS) uneven, thicker on longer side of shaft ..... *T. albata* sp. nov.
   Cirrus introvert swelling (IS) even, equally thick on both sides of shaft 7
7. Cirrus introvert opening oblique..... *T. argilla* sp. nov.
   Cirrus introvert opening very oblique..... 8
8. Cirrus introvert relatively large (Il:Ib= 5:1) .. *T. alba* sp. nov.
   Cirrus introvert relatively small (Il:Ib = 6:1) *T. arga* sp. nov.
9. Cirrus with aspinous introvert, very wide at base of shaft ..... *T. apicularis* sp. nov.
   Cirrus with spinous introvert..... 10
10. Cirrus introvert cylindrical ..... *T. maculata* sp. nov.
    Cirrus introvert not cylindrical 11
11. Cirrus introvert goblet-shaped, large.. *T. cypellum* sp. nov.*
    Cirrus introvert cone-shaped, small ..*T. keras* sp. nov.*

12. Introvert obviously spinous. 19
Introvert not obviously spinous (sometimes very tiny spines present) 13
13. Introvert present, but reduced 14
Introvert not present 16
14. Cirrus shaft short, broad, introvert strongly hooked . . . . . *T. uncuiculus* sp. nov.
Cirrus shaft long, tapering, introvert not greatly curved 15
15. Introvert cylindrical, though very thin *T. acicularis* sp. nov.
Introvert a tiny scoop. . . . . *T. gracilis* sp. nov.
16. Cirrus shaft distally with flared rim 17
Cirrus shaft distally with a blunt point 18
17. Cirrus shaft funnel-shaped . . . . . *T. aspinosa* sp. nov.
Cirrus shaft cone-shaped . . . . . *T. gingrina* sp. nov.
18. Cirrus shaft not much longer than base width (1:1) . . . . . *T. apiculus* sp. nov.
Cirrus shaft much longer than base width (3:1) . . . . . *T. belone* sp. nov.
19. Cirrus introvert length normally <100µm. 20
Cirrus introvert length normally >100µm. 27
20. Cirrus introvert very small, not obvious 21
Cirrus introvert prominent, obvious 22
21. Cirrus introvert slightly flared, small flame-like introvert, opening oblique . . . . . *T. flammula* sp. nov.
Cirrus introvert not flared, opening not (or very slightly) oblique . . . . . *T. minima* sp. nov.
22. Cirrus introvert opening transverse to oblique 23
Cirrus introvert opening very oblique 25
23. Cirrus introvert scoop-shaped. . . . *T. coughrani* sp. nov.
Cirrus introvert tending to cylinder-shaped. 24
24. Cirrus introvert cylinder to cone-shaped . *T. keras* sp. nov.*
Cirrus introvert cylinder to scoop-shaped, flame-shaped, shaft often curved. . . . . *T. fax* sp. nov.
25. Introvert swelling uneven, opening almost lateral . . . . . *T. bacrio* sp. nov.
Introvert swelling even, opening very oblique 26
26. Cirrus introvert relatively small (IIx1b c. 60x13µm) . . . . . *T. bacrioniculus* sp. nov.
Cirrus introvert relatively large (IIx1b c. 85x20µm) . . . . . *T. cestus* sp. nov.
27. Cirrus shaft long and narrow, introvert has a distinctly flared distal region (appears like a fly's proboscis) . . . . . *T. muscalingulata* sp. nov.
Cirrus not as above 28
28. Cirrus introvert hardly less wide than proximal shaft 29
Cirrus introvert bulbous (goblet-shaped) 30
29. Introvert with distinctive narrow distal region (tapered) . . . . . *T. possibilitas* sp. nov.
Introvert distal region not tapered. *T. comythus* sp. nov.
30. Cirrus with longer side of introvert on shorter side of shaft, large worms, pigment slightly punctate . . . . . *T. cypellum* sp. nov.*
Cirrus typical with short side of introvert on short side of shaft 31
31. Cirrus shaft proximally not much broader than distally (ratio <2:1) . . . . . *T. caliculus* sp. nov.
Cirrus shaft proximally much broader than distally (ratio >2:1). 32
32. Introvert swelling even 33
Introvert swelling uneven 34
33. Shaft funnel-shaped, flares proximally (Sb:Ib > 5:1) . . . . . *T. magna* sp. nov.
Shaft cone-shaped (Sb:Ib c. 3:1). . . . *T. maxima* sp. nov.
34. Introvert length >200µm. . . . . *T. batiola*
Introvert length < 200µm . . . . . *T. fasciata*

*[Note: Some species key out in more than one couplet since pigment distribution is not always a consistent character].

Temnosewellia acicularis sp. nov. (Fig. 19A–E)

ETYMOLOGY. From *acicularis* = like a needle (Latin); a reference to the thin needle-like cirrus.

MATERIAL. HOLOTYPE: QMG221094 (WM) from *Euastacus bidawalus* [QMW26588], Dingo Ck, crossing on Euchre Valley Drive, Lind NP, VIC (37°34.7'S 148°58.2'E), 20.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un. PARATYPES: QMG221095–221096 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG221097 (WM), 100% alc/Un; QMG221098–221101 (CP), 100% alc/Fau. OTHER MATERIAL: From *Euastacus crassus*. ACT: [QMW26603], QMG220994–220995 (WM), Kangaroo Ck, rd crossing above Corin Dam, Namadgi NP, ACT (35°32.3'S 148°52.2'E) 16.10.1991,L.R.G. Cannon & K.B. Sewell, Bouin/Hx; QMG220996–220997 (WM), Form/Hx; QMG220998–221004 (CP), HW/Form/Fau.; QMG221005 (LS[10]) Bouin/H&E; QMG221006–221007 (LS[7,2]) Form/H&E.

DESCRIPTION. Characteristics of genus and with typical pattern of body pigment. Selected body measurements of type specimens from *Euastacus bidawalus* are: QMG221094 (H): B(2856 × 1938), LE(1979), PH(407 × 650), SD(894), PD(407); QMG221095 (P): B(4284 × 3386), LE(3223), PH(423 × 577), SD(1138), PD(642); QMG221096 (P): B(3529 × 2550), LE(2509), PH(537 × 862), SD(1179), PD(488).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert cylinder to scoop-shaped; distal opening very oblique. Swelling uneven, wider on introvert longer side, does not extend proximally past introvert base on either side(?). Selected cirrus measurements of specimens from *Euastacus bidawalus* from type locality are: QMG221098: S(894 × 71), I(37 × 10), IS(na × na); QMG221099: S(303 × 30), I(37 × 10), IS(na × na); QMG221100: S(350 × 33), I(37 × 9), IS(na × na).

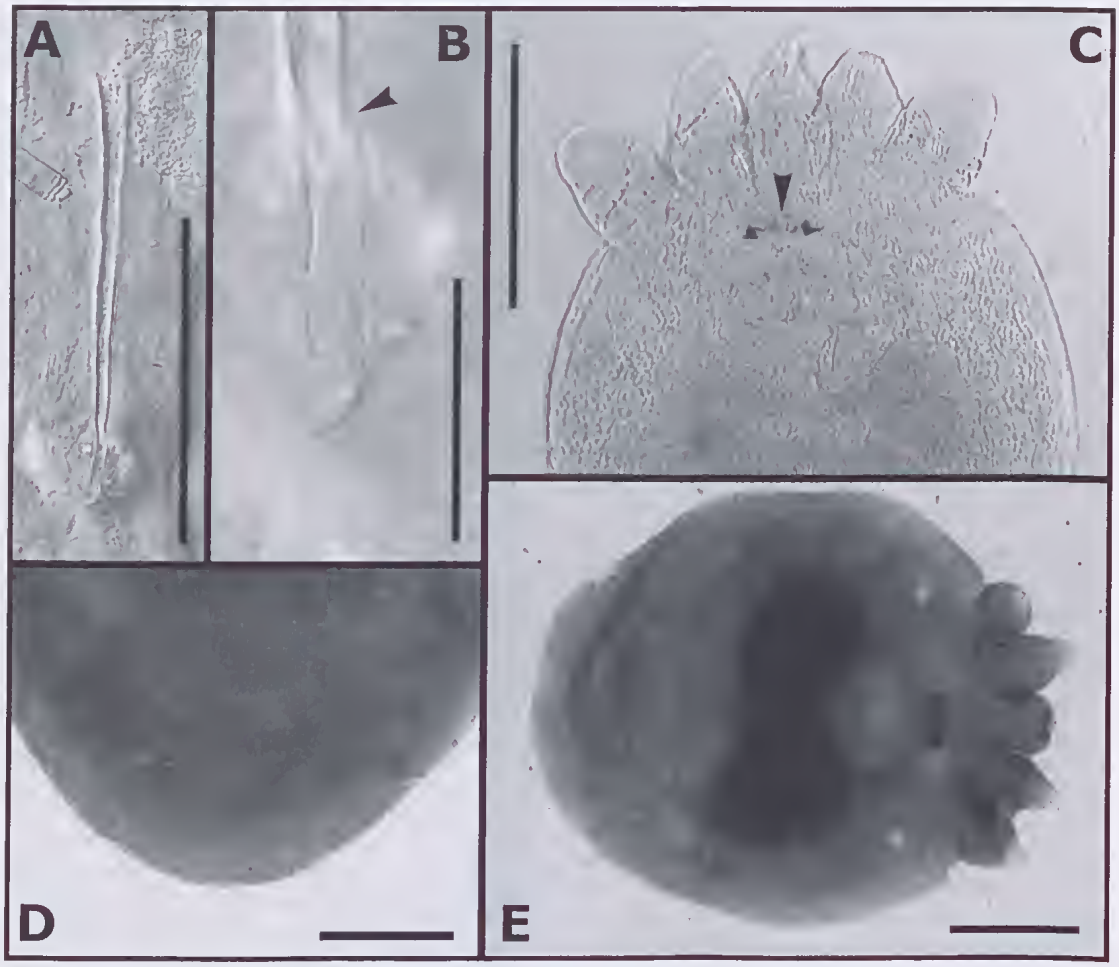


FIG. 19. *Temnosewellia acicularis* sp. nov. A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG221099, whole cirrus, scale = 250µm; B, QMG221099, introvert showing the introvert base (arrowhead), scale = 50µm; C, QMG221097, anterior end of small worm showing lack of body pigment except for a thin scatter of pigment between eyes (arrowhead), scale = 500µm; D, QMG221098, posterior end of large worm showing typical dorsal body pigment distribution, compare with C. Scale = 1mm; E, QMG221095, adult worm showing typical pattern of body pigment, scale = 1mm.

HOSTS. *Euastacus bidawalus*, *E. crassus*.

DISTRIBUTION. ACT — from Namadgi NP, near Corin Dam at Kangaroo Ck. North-eastern VIC — from east Gippsland, Lind NP at Dingo Ck.

REMARKS. Small worms have little body pigment except for the region around the eyes (Fig. 19C). The cirrus of this species is very slender and details of the introvert especially the swelling are difficult to resolve. The spines are very tiny and at the limits of LM resolution. The cirrus is superficially similar to that of *Temnosewellia gracilus* sp. nov., but is smaller overall, with a longer and narrower introvert.

Temnosewellia alba sp. nov.
(Fig. 20A–D)

ETYMOLOGY. From *albus* = white (Latin); a reference to the colour of this non-pigmented worm.

MATERIAL. HOLOTYPE: QMG220333 (WM), from *Euastacus* c.f. *balmensis* [QMW26595] Mt Bartle Frere, South Peak, Summit Ck beside 'Top Western' campsite, Wooroonooran NP, Qld (17°23.8'S 145°48.9'E), 27.11.1995, N. Connolly, 70% alc(?)/Un. PARATYPES: QMG220334 (WM), 70% alc(?)/Un; [QMW26594], QMG220335–220337 (WM), Jun. 2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26594], QMG220338–220339 (WM), Jun.

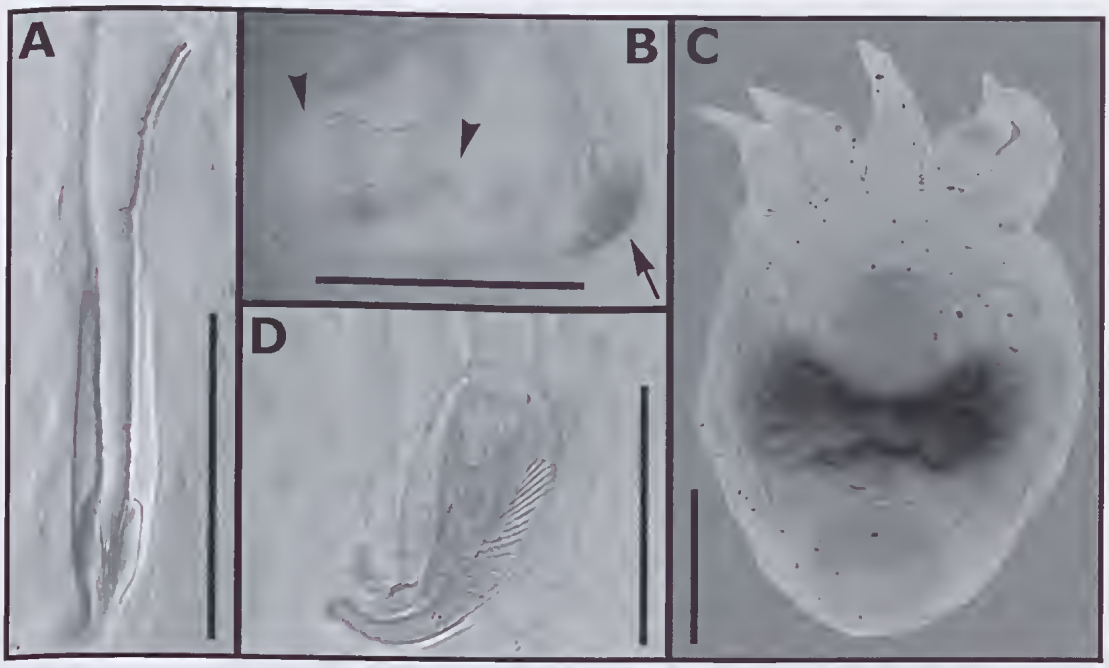


FIG. 20. *Temnosewellia alba* sp. nov. A-B, D. Nomarski interference contrast photomicrographs of Faure's preparations from *Euastacus* c.f. *balanensis*. A, QMG220343, whole cirrus, scale = 250µm; B, QMG2203432, introvert distal region (arrow) and weak sclerotisation in the distal vagina (arrowheads), scale = 250µm; C, QMG220334, adult worm (unstained) showing lack of dorsal body pigment, scale = 1mm; D, QMG220344, introvert, scale = 50µm.

2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un; [QMW26595], QMG220340–220341 (WM), 27.11.1995, N. Connolly, 70% alc(?)/Un; [QMW26594], QMG220342–220345 (WM), Jun.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Fau; [QMW26595], QMG220346–220357 (WM), 27.11.1995, N. Connolly, 70% alc(?)/Fau. OTHER MATERIAL. From *Euastacus balanensis*. Qld: [QMW26587], QMG220358–220361 (WM), Mt Haig, Kairi Ck trib., Lamb Ra. SF (17°06.0'S 145°35.5'E), 3.06.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un; [QMW17241 & QMW26677], QMG220362 (WM), 27.09.1990, L.R.G. Cannon & K.B. Sewell, Form-Acetic/Hx; [QMW26587], QMG220363 (WM), 3.06.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un; QMG220364–220369 (CP), 100% alc/Fau.

From *Euastacus fleckeri*. Qld: [QMW26611], QMG220370 (WM), Mt Lewis, Leichhardt Ck trib., at cement rd crossing above old forestry camp, Daintree River NP, Qld (16°35.8'S 145°16.7'E), 4.06.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un; QMG220371 (CP), Fau.

DESCRIPTION. Characteristics of genus but lacking body pigment. Selected body measurements of type specimens from *Euastacus* c.f. *balanensis* are: QMG220333 (H): B(3366 × 2224), LE(2040), PH(653 × 796), SD(796), PD(367); QMG220334 (P): B(3835 × 2407), LE(2448), PH(796 × 1040), SD(959), PD(510); QMG220335 (P): B(2591 × 1673), LE(1836), PH(469 × 694), SD(857), PD(286); QMG220336 (P): B(2203 × 1775), LE(1754), PH(510 × 694), SD(530), PD(265); QMG220337 (P): B(2509 × 1979), LE(1754), PH(510 × 694), SD(530), PD(265).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped; distal opening very oblique, often folded into hourglass or irregular shape. Swelling near even, extends proximally well past introvert base on both sides (sometimes along almost entire length of narrow tubular distal region of shaft?). Selected cirrus measurements of specimens from *Euastacus* c.f. *balanensis* from type locality are: QMG220343: S(348 × 77), I(159 × 30), IS(169 × 159); QMG220344: S(553 × 183), I(161 × 33), IS(423 x 276); QMG220345: S(335 × 63), I(142 × 30), IS(148 X. 152).

HOSTS. *Euastacus balanensis, E.* c.f. *balanensis, E. fleckeri*.

DISTRIBUTION. North-eastern Qld — from the Atherton Tableland region, W of Cairns, at Mt Bartle Frere and Mt Haig; and from Mt Lewis, W of Mossman.

REMARKS. This worm reaches a relatively large size with specimens collected from the type locality being greater than 5 mm body length. Several large specimens were observed to occasionally have a very thin, short tracery of pigment posterior to one or both eyes. This worm has the largest cirrus of all the northern Queensland species. The cirrus is closest to *Temnosewellia arga* sp. nov. though the introvert is proportionally larger than in the latter. The weakly sclerotised inner surface of the distal vagina in Faures's medium has a finely ruffled appearance, but lacks teeth.

Temnosewellia albata sp. nov.
(Fig. 21A–F)

ETYMOLOGY. From *albatus* = dressed in white (Latin); a reference to the colour of this non-pigmented worm.

MATERIAL. HOLOTYPE: QMG220414 (WM), from *Euastacus robertsi* [QMW26646], Mt Finnigan, Horans Ck [trib of Annan R], Cedar Bay NP, Qld (15°49.1'S 145°16.7'E), 5.06.2002, L. Roberts, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un. PARATYPES: QMG220415–220417 (WM), 100% alc/Un; [QMW5323–5324], QMG220418 (WM) 27–29.11.1975, L. Roberts, R. Monroe & G. Ingram. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26646], QMG220419–220420 (WM), 5.06.2002, L.Roberts, D. Blair, D. Hansman. K.B. Sewell & M.S. Bryant, 100% alc/Un; [QMW5323–5324], QMG220421 (WM), 27–29.11.1975, L. Roberts, R. Monroe & G. Ingram, 70% alc(?)/Hx; [QMW26646], QMG220422–220427 (CP), 5.06.2002, L. Roberts, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Fau; [QMW5323–5324], QMG220428 (LS[2]), 27–29.11.1975, L. Roberts, R. Monroe & G. Ingram, 70% alc(?)/H&E. OTHER MATERIAL: From *Euastacus robertsi*. Qld: [QMW26647], QMG220429 220431 (WM), Mt Finnigan, Parrot Ck trib., Cedar Bay NP (15°49.4'S 145°16.5'E), 5.06.2002, L. Roberts, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un; QMG220434–220435 (CP), 100% alc/Fau.

From *Cherax depressus* complex *sensu* Riek, 1951. Qld: [QMW26578] QMG221185 (CP), Mt Elliot, upper North Ck, Cape Bowling Green NP (19°28.1'S 146°57.9'E), 30.05.2002, K.B. Sewell & M.S. Bryant, 100% alc/Fau.

DESCRIPTION. Showing characteristics of genus but lacking body pigment except for the eyes. Selected body measurements of type specimens from *Euastacus robertsi* are: QMG220414 (H): B(2672 × 1673), LE(1795), PH(510 × 734), SD(673), PD(326); QMG220415 (P): B(2387 × 1306), LE(1632), PH(530 × 653), SD(592), PD(245); QMG220416 (P): B(2448 × 1734), LE(1734), PH(510 × 755), SD(612), PD(306); QMG220417 (P): B(2081 × 1693), LE(1550), PH(551 × 816), SD(530), PD(306); QMG220418 (P): B(2652 × 1530), LE(1754), PH(673 × 796), SD(469), PD(306).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop shaped; distal opening very oblique, large. Swelling uneven, extends proximally well past introvert base on longer side (swelling on shorter side not observed clearly). Selected cirrus measurements of specimens from *Euastacus robertsi* from type locality are: QMG220422: S(352 × 77), I(63 × 14), IS (116 × na); QMG220424: S(321 × 77), I(71 × 16), IS (152 × 110(?)); QMG220425: S(301 × 55), I(71 × 16), IS (89 × 91(?)); QMG220426: S(325 × 71), I(71 × 16), IS (126 × 91(?)).

HOSTS. *Cherax depressus* complex *sensu* Riek, 1951, *Euastacus robertsi*.

DISTRIBUTION. North-eastern Qld — from S of Cooktown, at Mt Finnigan NP; and from the Townsville region, Cape Bowling Green NP, Mt Elliot, at upper North Ck.

REMARKS. The cirrus is similar to that of *Temnosewellia argilla* sp. nov. and *T. aspra* sp. nov., but is slightly smaller than the first and slightly larger than the second; furthermore the swelling is uneven, unlike the other two. The extent of the introvert swelling on the shorter side was consistently difficult to resolve with confidence.

The inner lining of the distal vagina, although sometimes obvious in Faure's preparations, is clearly far less sclerotised than that found in *Temnohaswellia* species.

We have included here the single specimen collected from a representative of the *Cherax depressus* complex at Mt Elliot. No temnocephalans were found on any of several small specimens of *Euastacus bindal* collected there as part of this study, nor from any specimens of this host lodged in the QM collections. We suspect, however, that *Temnosewellia albata* sp. nov. will eventually be shown to be associated with *Euastacus bindal* at Mt Elliot, given the fact the the worm is present in the ecosystem.

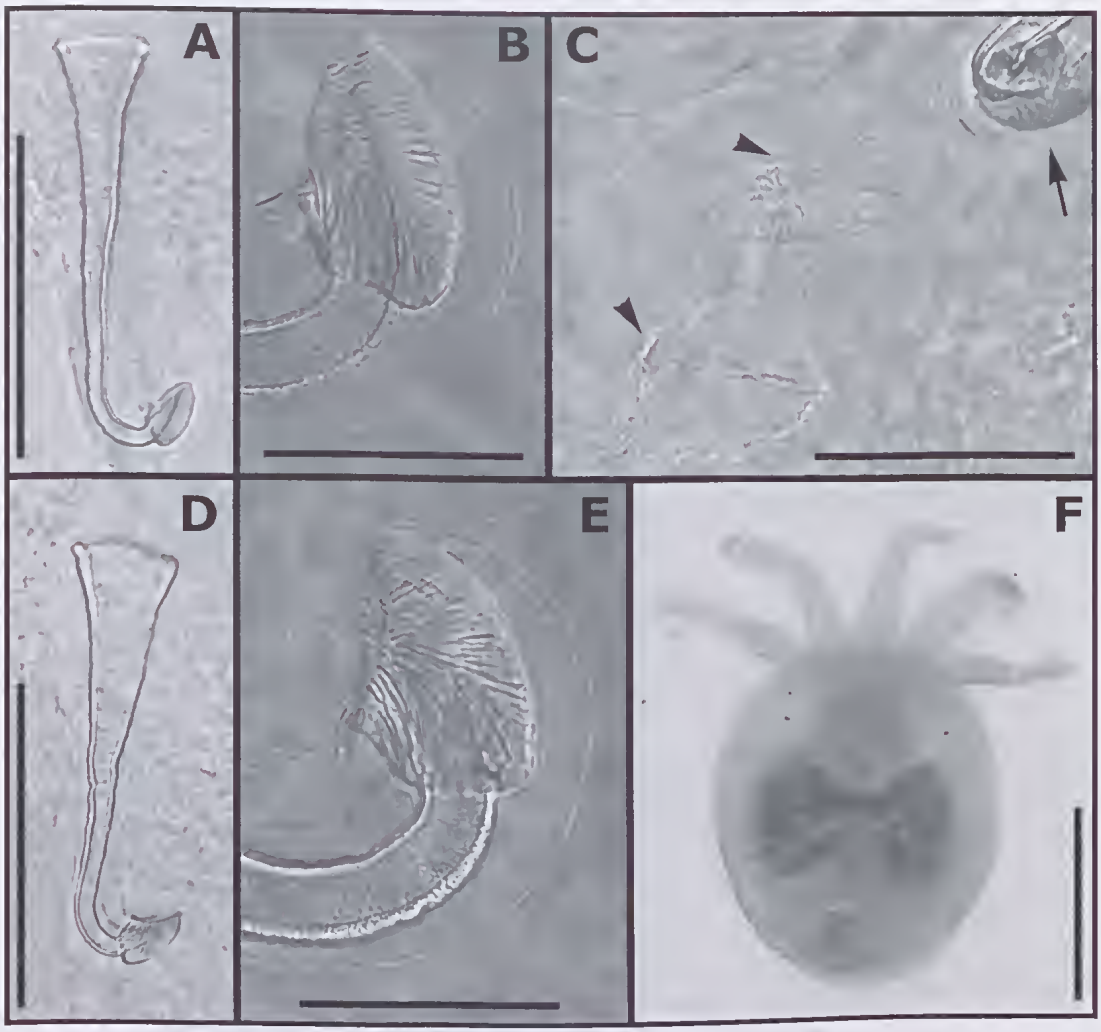


FIG. 21. *Temnosewellia albata* sp. nov. A–C. Nomarski interference contrast photomicrographs of Faure's preparations from *Euastacus robertsi*. A, QMG220423, whole cirrus, scale = 250μm; B, QMG220423, introvert, scale = 50μm; C, QMG220422, introvert distal region (arrow) and weak sclerotisation in the distal vagina (arrowheads), scale = 100μm; D, E. Nomarski interference contrast photomicrographs of Faure's preparations from *Cherax depressus*; D, QMG221185, whole cirrus, scale = 250μm; E, QMG221185, introvert, scale = 50μm; F, QMG220418, adult worm showing lack of dorsal body pigment, scale = 1mm.

Temnosewellia aphyodes sp. nov.
(Fig. 22A–C)

ETYMOLOGY. From *aphyodes* = whitish (Greek); a reference to the colour of this non-pigmented worm.

MATERIAL. HOLOTYPE: QMG220447 (WM), from *Euastacus fleckeri* [QMW26611], Mt Lewis, Leichhardt Ck trib., at Cement Rd crossing above old forestry camp, Daintree River NP, Qld (16°35.8'S 145°16.7'E), 4.06.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un. PARATYPES: QMG220448–220449 (WM), 100% alc/Un; [QMW26616], QMG220450 (WM), 26.09.1990, L.R.G. Cannon & K.B. Sewell, Carn/Hx. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26611], QMG220451–220459 (CP), 4.06.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Fau; [QMW26616], QMG220460 (CP), 26.09.1990, L.R.G. Cannon & K.B. Sewell, Carn(?)/Hx.

OTHER MATERIAL. From *Euastacus fleckeri*. Qld: [unreg. host], QMG220461–220462 (WM), Mt Lewis, in rain forest stream, (16°35'S 145°17'E), Jan. 1986, L. Winsor, 70% alc(?)/Hx; [QMW26613], QMG220469 (CP) Mt Lewis (16°35'S 145°17'E), 14.01.1990, ANZSES Expedition Daintree Falls

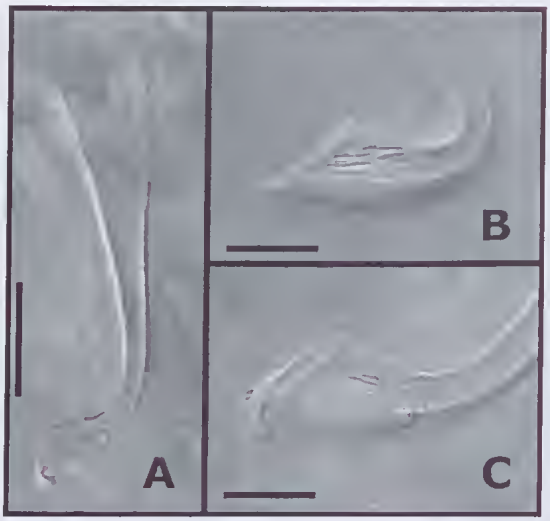


FIG. 22. *Temnosewellia aphyodes* sp. nov. A–C. Nomarski interference contrast photomicrographs of Faure's preparations from *Euastacus fleckeri*. A, QMG220455, whole cirrus, scale = 50µm; B, QMG220451, introvert, scale = 20µm; C, QMG220455, introvert, scale = 20µm.

1989/90, 70% alc(?)/Fau; QMG220463 (LS[1]); [QMW26612], QMG220464–220465 (WM), Dollins Ck, headwaters of Mossman R. (16°28'S 145°16'E) 23.12.1989, G.B. Monteith, 70% alc(?)/Hx; [QMW26615], QMG220466–220468 (WM), Pauls Luck, junction of Doolins & Platypus Cks, Daintree NP (16°26.5'S 145°15.2'E) 1.01.1990, ANZSES Expedition Daintree Falls, 70% alc(?)/Hx; QMG220470 (LS[1]), 70% alc(?)/H&E; [QMW26614], QMG220471 (WM), upper Cow Creek, 1.5km NE Mt Spurgeon (16°26'S 145°13'E) 21.10.1991, L. Roberts, 70% alc(?)/Hx; [QMW26618], QMG220472 (WM), upper Stewart Creek, 4 km NNE Mt Spurgeon (16°24'S 145°13'E), 20.10.1991, Monteith G.B. & Janetzki H., 70% alc(?)/Hx; [QMW26617], QMG220473–220474 (WM), upper Stony Creek, 2.5km NE Mt Spurgeon (16°22'S 145°13'E), 15.10.1991, G.B. Monteith & H. Janetzki, 70% alc(?)/Hx; QMG220475–220476 (LS[2,2]), 70% alc(?)/Hx; [unreg. host], QMG220477 (WM), Carbine (Hill?), NQ Tableland (16°31'S 145°08'E), 30.11.1990, Monteith G.B. & party, 70% alc(?)/Hx.

DESCRIPTION. Characteristics of genus but lacking body pigment. Selected body measurements of type specimens from *Euastacus fleckeri* are: QMG220447 (H): B(2672 × 1275), LE(1652), PH(408 × 500), SD(439), PD(224); QMG220448 (P): B(1520 × 816), LE(1061), PH(235 × 296), SD(367), PD(163); QMG220449 (P): B(1754 × 1040), LE(1204), PH(286 × 357), SD(286), PD(122); QMG220450 (P): B(2122 × 1122), LE(1469), PH(265 × 520), SD(551), PD(245).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped; distal opening very oblique, often folded into hourglass or irregular shape. Swelling near-even, extends proximally slightly past introvert base on both sides, slightly further on longer side. Selected cirrus measurements of specimens from *Euastacus fleckeri* from type locality are: QMG220451: S(173 × 33), I(41X 8), IS(24 × 12); QMG220455: S(183 × 47), I(45X 8), IS(16 × 6); QMG220457: S(157 × 39), I(39X 8), IS(27 × na); QMG220459: S(150 × 39), I(45X 9), IS(16 × 16).

HOST. *Euastacus fleckeri*.

DISTRIBUTION. North-eastern Qld — from the region W of Mossman, in the areas of Mt Spurgeon, Mt Lewis and Mt Carbine.

REMARKS. This species has the smallest cirrus of all the northern Queensland species and its small size makes observation of fine details of the introvert difficult. The cirrus was often strongly curved in Faure's medium, but the cirrus of the holotype WM is straight. The cirrus is closest to that of *Temnosewellia aspra* sp. nov., but is slightly smaller overall and the introvert swelling, unlike that of *T. aspra* sp. nov., is short on both sides of the shaft.

Temnosewellia apiculus sp. nov.
(Fig. 23A–G)

ETYMOLOGY. From *apiculus* = a little apex (Latin); a reference to the small pointed structure at the apex of the cirrus shaft.

MATERIAL. HOLOTYPE: QMG221102 (WM), from *Euastacus kershawi* [QMW26630], Labertouche Ck (Tarago R. trib.), on Old Telegraph Rd, W of Jindivick, VIC (38°03.2'S 145°50.1'E), 21.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un. PARATYPES: QMG221103–221107 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: From *Euastacus kershawi*.VIC: [QMW26630], QMG221108–221116 (CP), 100% alc/Fau.

From unknown host. VIC: [unreg. host], NMVF 93838 (WM), Neerim, (37°58'S 145°57'E), 10.04.1906, Fulton S.W, unknown fixative/carmine(?).

From 'freshwater cray' VIC: [unreg. host], NMVF 93839–93841 (WM), Moe River, VIC, (38°11'S 145°59'E), 4.12.1886, unknown fixative/carmine(?); NMVF 93842–93845 (CP), unknown fixative/Fau;

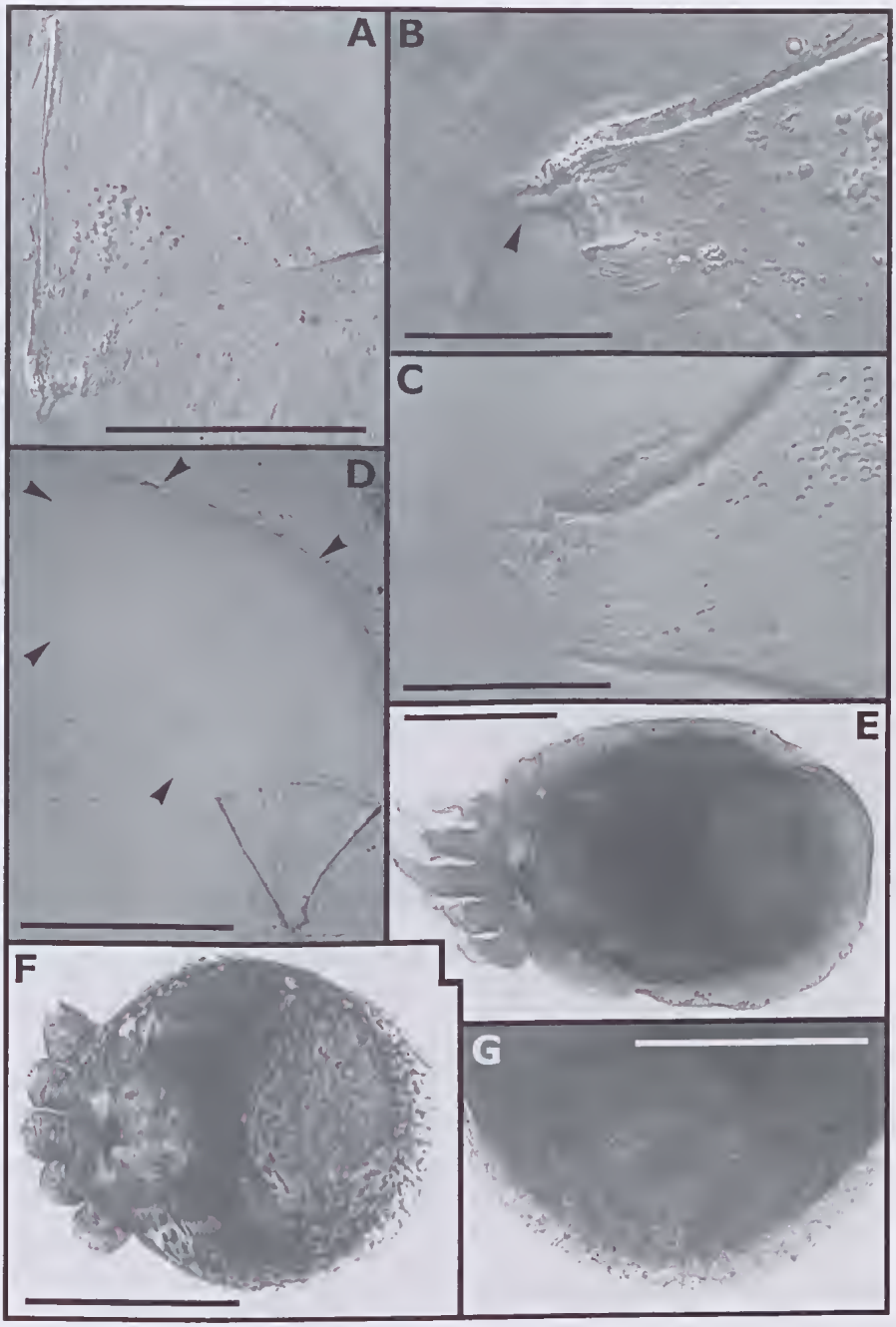


FIG. 23. *Temnosewellia apiculus* sp. nov. A–D. Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG221112, whole cirrus, scale = 200µm; B, QMG221112, introvert showing the apical pointed structure (arrowhead), scale = 100µm; C, QMG221110, introvert showing the apical pointed structure, scale = 100µm; D, QMG221112, whole cirrus showing the large copulatory bulb (arrowheads). Scale = 500µm; E, QMG221105, dorsal view of worm showing non-punctate body pigment, scale = 2mm; F, QMG221107, dorsal view of worm showing punctate body pigment, scale = 2mm; G, GMG221108, posterior end of worm showing slightly punctate body pigment in the lateral margins of the body, scale = 2mm.

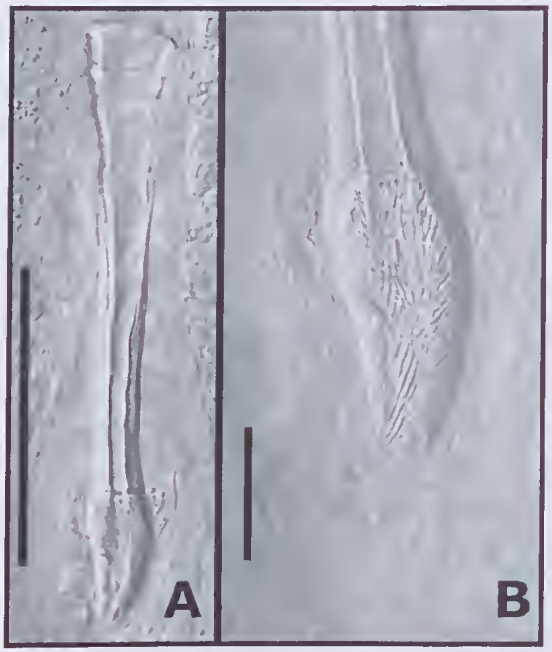


FIG. 24. *Temnosewellia arga* sp. nov. A-B, Nomarski interference contrast photomicrographs of Faure's preparations from *Euastacus yigara*. A, QMG220377, whole cirrus, scale = 250µm; B, QMG220377, introvert, scale = 20µm.

NMVF 93846–93851 (LS[6,4,6,6,7,5), unknown fixative/H&E(?).

DESCRIPTION. Characteristics of genus; pattern of pigmention variable often typical but occasionally punctate. Selected body measurements of type specimens from *Euastacus kershawi* are: QMG221102 (H): B(7426 × 3366), LE(6120), PH(734 × 1020, SD(1734), PD(877); QMG221103 (P): B(6079 × 2815), LE(4937), PH(714 × 836), SD(1428, PD(408); QMG221104 (P): B(6059 × 3754), LE(4427), PH(775 × 1040), SD(1734), PD(653); QMG221105 (P): B(6100 × 3733), LE(4529), PH(775 × 1020), SD(1836, PD(571); QMG221106 (P): B(6814 × 3101), LE(5284), PH(653 × 918), SD(1734), PD(714).

Reproductive System. Male. Cirrus: Shaft cone-shaped with wide proximal opening. Introvert lacks spined region, but has apical pointed structure (about 40 long) attached to introvert base. Swelling not observed [absent?]. Selected cirrus measurements of specimens from *Euastacus kershawi* from type locality are: QMG221109: S(372 × 453), I(- × 53), IS(na × na); QMG221110: S(447 × 407), I(- × 69), IS(na × na); QMG221111: S(244 × 193), I(- × 53), IS(na × na); QMG221112: S(321 × 392), I(- × 53), IS(na × na); QMG221113: S(370 × 372), I(- × 61), IS(na × na).

HOST. *Euastacus kershawi.*

DISTRIBUTION. From the central Gippsland region of VIC.

REMARKS. This worm is large, reaching close to 7.5mm body length. The pigment pattern is slightly variable (Figs 23E–F). Some specimens, not necessarily the largest, have only a slightly punctate pattern, most noticable in the lateral margins of the body (Fig. 23G). The cirrus nevertheless is unlike any other and serves to readily distinguish this species. It lacks an introvert but has in its place (apparently), an apical, pointed structure that lacks spines. The copulatory bulb is extremely large relative to the size of the cirrus (Fig. 23D). The wide proximal opening of the cirrus of this species was observed to widen even more over time when placed in Faure's medium.

Temnosewellia arga sp. nov.
(Fig. 24A–B)

ETYMOLOGY. From *arga* = white (Latinised Greek); a reference to the colour of this non-pigmented worm.

MATERIAL. HOLOTYPE: QMG220372 (WM), from *Euastacus yigara* [QMW26675], O'Leary Ck, trib. of the upper Tully R., at Old Culpa Rd concrete causeway, Koombooloomba FR, Qld (17°57.0'S 145°39.1'E), 31.05.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un. PARATYPES: QMG220373–220376 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220377–220381 (CP), 100% alc/Fau; QMG220863 (CP), 100% alc/Fau.

DESCRIPTION. Characteristics of genus but lacking body pigment. Selected body measurements of type specimens from *Euastacus yigara* are: QMG220372 (H): B(2876 × 1632), LE(1693), PH(449 × 653, SD(632), PD(245); QMG220373 (P): B(2489 × 1734), LE(1652), PH(510 × 653), SD(612), PD(265); QMG220374 (P): B(2754 × 1652), LE(2040), PH(510 × 653), SD(673), PD(286); QMG220375 (P): B(2407 × 1734), LE(1693), PH(428 × 673), SD(571), PD(286); QMG220376 (P): B(2836 × 1754), LE(1877), PH(530 × 714), SD(612), PD(326).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped; distal opening very oblique, often folded into hourglass or irregular shape. Swelling even, extends proximally well past introvert base on both sides (along entire length of narrow tubular distal

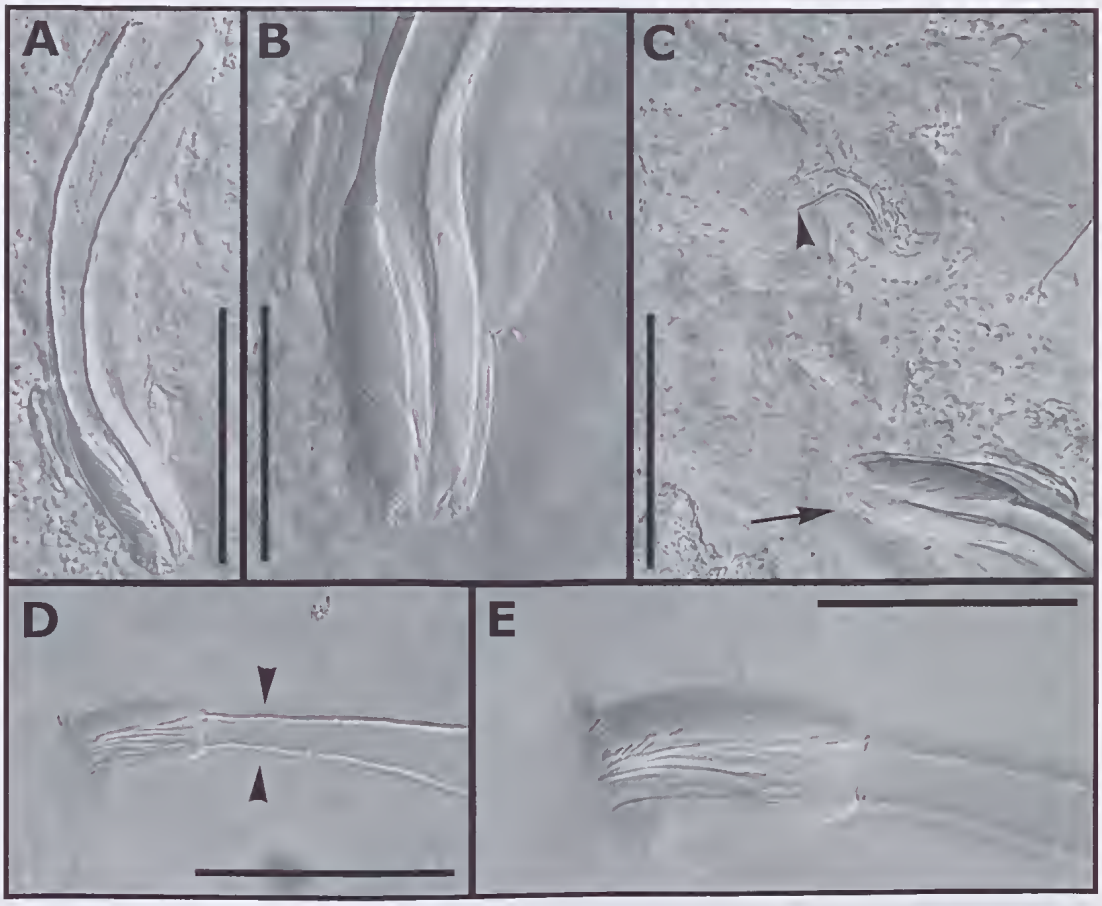


FIG. 25. *Temnosewellia argeta* sp. nov. A–C, Nomarski interference contrast photomicrographs of Faure's preparations from *Euastacus yigara*. A, QMG220485, whole cirrus, scale = 100µm; B, QMG220485, introvert, scale = 50µm; C, QMG220485, introvert distal region (arrow) and weak sclerotisation in the distal vagina (arrowhead), scale = 100µm; D–E, Nomarski interference contrast photomicrographs of Faure's preparations from *Cherax parvus*; D, QMG221186, cirrus distal region showing the near even introvert swelling swelling (arrowheads), scale = 100µm; E, QMG221186, introvert partially everted, scale = 50µm.

region of shaft). Selected cirrus measurements of specimens from *Euastacus yigara* from type locality are: QMG220377: S(386 × 77), I(124 × 19), IS(209 × 254); QMG220378: S(417 × 93), I(130 × 19), IS(234 × 250); QMG220380: S(419 × 75), I(118 × 20), IS(228 × 209); QMG220381: S(362 × 65), I(118 × 21), IS(189 × 224).

HOST. *Euastacus yigara*.

DISTRIBUTION. North-eastern Qld — from the Cardwell Ra., at O' Leary Ck, a tributary of the upper Tully R., in Koombooloomba FR.

REMARKS. The cirrus is most similar to that of *Temnosewellia alba* sp. nov. but is slightly smaller with a relatively smaller introvert.

Temnosewellia argeta sp. nov.
(Fig. 25A–E)

ETYMOLOGY. From *argetos* = white (Greek); a reference to the colour of this non-pigmented worm.

MATERIAL. HOLOTYPE: QMG220478 (WM), from *Euastacus yigara* [QMW18121], O'Leary Ck, trib. of the upper Tully R., at Old Culpa Rd concrete causeway, Koombooloomba FR, Qld (17°57.0'S 145°39.1'E), 7.11.1992, J.W. Short & P.J.F. Davie, Bouin/Un. PARATYPES: QMG220479–220482 (WM), Bouin/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220483–220487 (CP), HW/Form/Fau; from *Cherax parvus* [QMW26639], QMG221186–221190 (CP), 31.05.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un.

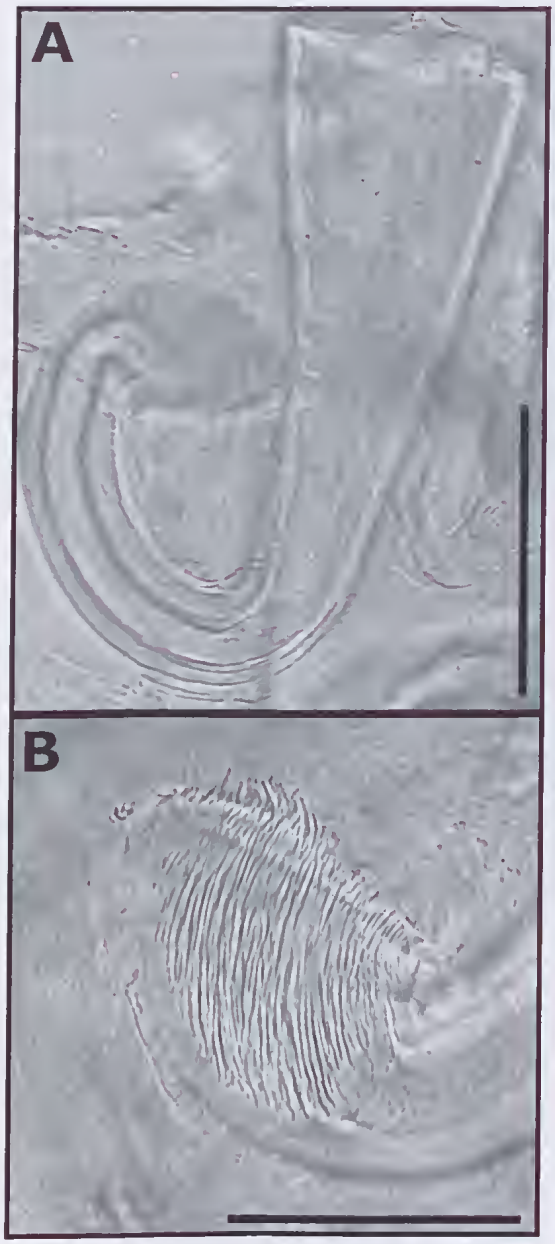


FIG. 26. *Temnosewellia argilla* sp. nov. from *Euastacus fleckeri*. A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220385, whole cirrus, scale = 100μm; B, QMG220385, introvert, scale = 50μm.

DESCRIPTION. Charaeteristies of genus but lacking body pigment. Seleeted body measurements of type speeimens from *Euastacus yigara* are: QMG220478 (H): B(1098 × 732), LE(789), PH(163 × 301), SD(260), PD(130); QMG220479 (P): B(1024 × 659), LE(732), PH(171 × 293), SD(285), PD(114); QMG220480 (P): B(1049 × 691), LE(837), PH(203 × 301), SD(268), PD(122); QMG220481 (P): B(1406 × 927), LE(854), PH(195 × 366), SD(309), PD(154); QMG220482 (P): B(1033 × 789), LE(715), PH(220 × 341), SD(285), PD(126).

Reproductive System. Male. Cirrus: Shaft eone-shaped. Introvert eylinder to seoop-shaped; distal opening oblique. Swelling near-even, extends proximally well past introvert base on both sides, slightly further on shorter side. Seleeted cirrus measurements of speeimens from *Enastacus yigara* are: QMG220483: S(193 × 37), I(67 × 14), IS(57 × 63); QMG220484: S(181 × 35), I(63 × 13), IS(45 × 45); QMG220485: S(171 × 33), I(63 × 13), IS(37 × 45); QMG220486: S(173 × 30), I(69 × 12), IS(59 × 37).

HOSTS. *Cherax parvus*, *Euastacus yigara*.

DISTRIBUTION. North-eastern Qld — from the Cardwell Ra., at O' Leary Ck, a tributary of the upper Tully R., in Koomboolоomba FR.

REMARKS. *Temnosewellia argeta* sp. nov. is similar to the other non-pigmented north Queensland speeies. The eirrus is most like that of *T. aspra* sp. nov., but the introvert laeks the very oblique opening of the latter.

We found *Temnosewellia argeta* sp. nov. on both *Enastaeus yigara* and *Cherax parvus* at the O'Leary Ck site. These two speeies of erayfish as well as the shrimps *Caridina zebra* Short, 1993 and *Macrobrachium* sp. are sympatrie at this loeality (Short & Davie, 1993). The latter two speeies listed were not, however, examined for temnoeephalans.

Temnosewellia argilla sp. nov.
(Fig. 26 A–B)

ETYMOLOGY. From *argilla* = white clay, potter's clay (Latin, feminine); a reference to the colour of this non-pigmented worm.

MATERIAL. HOLOTYPE: QMG220382 (WM), from *Euastacus fleckeri* [QMW26616], Mt Lewis, Leichhardt Ck trib., at cement rd crossing above old forestry camp, Daintree River NP, Qld (16°35.8'S 145°16.7'E), 26.09.1990, L.R.G. Cannon & K.B. Sewell, Form-Acetic/Hx. PARATYPES: QMG220383–220384 (WM), Carn/Hx. OTHER MATERIAL FROM TYPE LOCALITY: QMG220385–220387, (CP) Form(?)/Fau. OTHER MATERIAL. From *Euastacus fleckeri*. Qld: [QMW26613], QMG220388–220389

(WM), Mt Lewis (16°35'S 145°17'E), 14.01.1990, ANZSES Expedition to Daintree Falls, 70% alc(?)/Hx; QMG220390–220392 (LS[3,3,4]), 70% alc(?)/H&E; [unreg. host], QMG220393 (WM), Mt Lewis (16°35'S 145°17'E), Jan. 1986, L. Winsor, 70% alc(?)/Hx; QMG220394 (LS[1]); [QMW26615], QMG220395 (WM), Pauls Luck, junction of Doolins & Platypus Cks, Daintree NP (16°26.5'S 145°15.2'E), 1.01.1990, ANZSES Expedition to Daintree Falls, 70% alc(?)/Hx; QMG220396–220398 (CP), 70% alc(?)/Fau; QMG220399–220402 (LS[1,2,4,2]), 70% alc(?)/H&E; [QMW26614], QMG220403–220404 (WM), upper Cow Creek, 1.5km NE Mt Spurgeon (16°26'S 145°13'E) 21.10.1991, L. Roberts, 70% alc(?)/Hx; QMG220405 (CP) 70% alc(?)/Fau; QMG220406–220407 (LS[2,1]), 70% alc(?)/H&E; [QMW26618], QMG220408–220409 (WM), upper Stewart Creek, 4 km NNE Mt Spurgeon (16°24'S 145°13'E), 20.10.1991, G.B. Monteith & H. Janetzki, 70% alc(?)/Hx; [QMW26612], QMG220410 (CP), Dollins Ck, headwaters of Mossman R. (16°28'S 145°16'E), 23.12.1989, G.B. Monteith, 70% alc(?)/Fau; QMG220411 (LS[1]), 70% alc(?)/H&E; [unreg. host], QMG220412–220413 (WM), Carbine (Hill?), NQ Tableland (16°31'S 145°08'E) 30.11.1990, G.B. Monteith and party, 80% alc/Hx.

DESCRIPTION. Showing characteristics of genus but lacking pigment except for eyes. Selected body measurements of type specimens from *Euastacus fleckeri* are: QMG220382 (H): B(1999 × 1142), LE(1224), PH(306 × 388), SD(388), PD(204); QMG220383 (P): B(1632 × 1204), LE(1020), PH(224 × 408), SD(388), PD(204); QMG220384 (P): B(1816 × 1142), LE(1265), PH(245 × 490), SD(439), PD(235).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped; distal opening oblique, large. Swelling near-even, extends proximally far past introvert base on both sides (along entire length of narrow tubular distal region of shaft). Selected cirrus measurements of specimens from *Euastacus fleckeri* from type locality are: QMG220385: S(411 × 89), I(77 × 18), IS(244 × 182); QMG220386: S(457 × 89), I(65 × 18), IS(285 × 209); QMG220387: S(na × na), I(77 × 18), IS(na × na).

HOST. *Euastacus fleckeri.*

DISTRIBUTION. North-eastern Qld — from the region W of Mossman, in the areas of Mt Spurgeon, Mt Lewis and Mt Carbine.

REMARKS. The cirrus is closest to that of *Temnosewellia albata* sp. nov. but is slighty larger overall and the spines are different. The introvert swelling is even, rather than uneven as in *Temnosewellia albata* sp. nov. Although the specimens examined here were not optimally preserved, the cirrus remains a reliable character.

Temnosewellia aspinosa sp. nov.
(Fig. 27A–C)

ETYMOLOGY. From *spina* = thorn (Latin, feminine); a reference to the introvert lacking spines.

MATERIAL. HOLOTYPE: QMG220689 (WM), from *Euastacus valentulus* [QMW26667], upper Tallebudgera Ck, at 'Fern Gully' (28°13.7'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un. PARATYPES: QMG220690–220693 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220695–220700 (CP), 100% alc/Fau. OTHER MATERIAL. From *Euastacus valentulus*. Qld: [QMW25589], QMG220701–220703 (WM), Cougal Ck, in cleared paddock nr 'Twin Pools', upper Tallebudgera Valley (28°12.8'S 153°20.4'E), 8.11.2000, D.J. Cook, hot Form/Un; [QMW26668], QMG220704–220707 (WM), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un; QMG220708–220710 (CP), 100% alc/Fau; QMG220711–220713 (CP), Fau; [unreg. host, ident. Dr John Short, QM], QM 220714–220716 (WM) upper Tallebudgera Ck (28°13'S 153°20'E), 13.10.1990, G.B. Monteith, 70% alc(?)/MB/Hx; QM 220717–220719 (LS[5,5,6]), 70% alc(?)/H&E. NSW: [unreg. host] QMG220720–220722 (WM), Burringbar Ck at Greenvale Crt, NSW (28°27'S 153°28'E) 14.10.2001, I. Fox & P. Fox, hot Form/Un; QMG220723–220724 (CP), 100% alc/Fau; QMG220725–220726 (CP), hot Form/Fau; QMG220727–220728 (CP), Fau.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus valentulus* are: QMG220689 (H): B(7160 × 4386), LE(5508), PH(1204 × 1693), SD(2122), PD(1020); QMG220690 (P): B(4243 × 2836), LE(3223), PH(673 × 1020), SD(1224), PD(612); QMG220691 (P): B(5651 × 4284), LE(4488), PH(653 × 1530), SD(1714), PD(796); QMG220692 (P): B(6814 × 3672), LE(5018), PH(979 × 1326), SD(1775), PD(775); QMG220693 (P): B(6242 × 3978), LE(4692), PH(1020 × 1734), SD(2244), PD(898).

Reproductive system. Male. Cirrus: Shaft cone-shaped. Introvert lacks spined region, but has low, rounded, cusp-like protuberences on rim of distal shaft; distal opening not oblique (i.e. corresponds to introvert base). Swelling even, extends proximally slightly past introvert base, about an equal distance on both sides. Selected cirrus measurements of specimens from *Euastacus valentulus* from type locality are: QMG220695; S(364 × 207), I(na × 71), IS(10 × 10); QMG220696; S(396 × 203), I(na

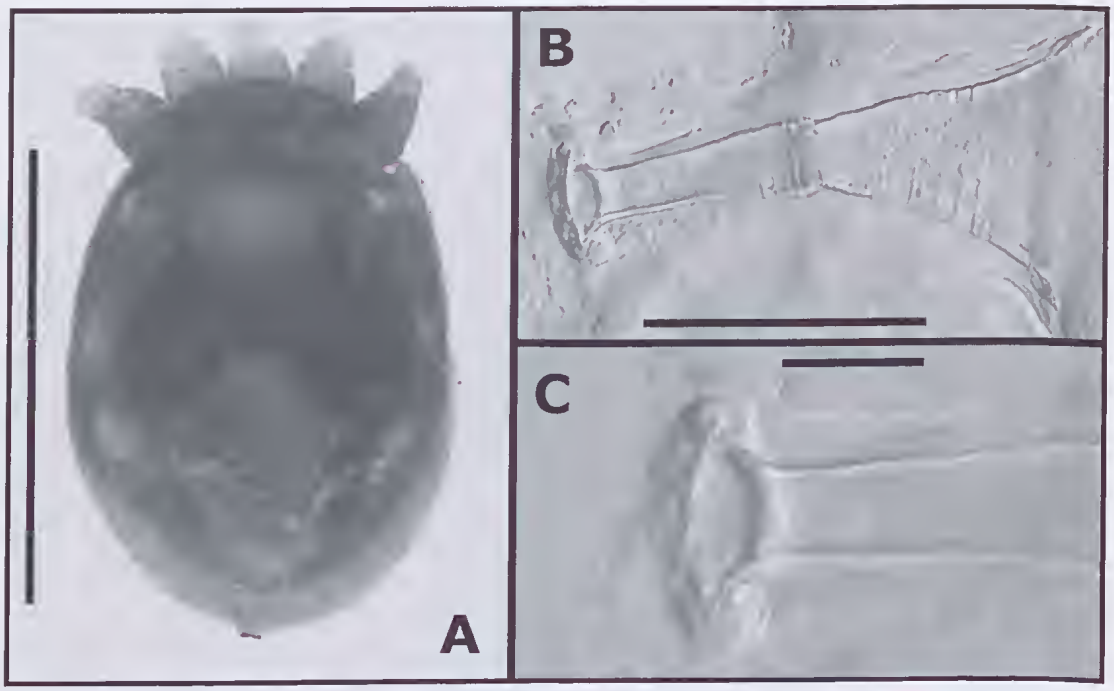


FIG. 27. *Temnosewellia aspinosa* sp. nov. from *Euastacus valentulus*. A, QMG220689, whole worm showing distribution of pigment, scale = 5mm; B–C, Nomarski interference contrast photomicrographs of Faure's preparations; B, QMG220696, whole cirrus scale = 200µm; C, QMG220696, introvert distal region, scale = 50µm.

× 65), IS(10 × 10); QMG220698; S(373 × 165), I(na × 53), IS(10 × 10); QMG220700; S(348 × 152), I(na × 53), IS(10 × 10).

HOST. *Euastacus valentulus*.

DISTRIBUTION. Known only from the southern border region of Qld and north-eastern NSW.

REMARKS. This species is large, with some specimens longer than 7mm. The introvert appears reduced to a series of short vestigal teeth, enclosed in a ring of bulbous cusps, presumably formed by the introvert swelling. Accurate assignment of homology for these structures would, however, require electron microscopy. The only other species with a similar reduced introvert is *Temnosewellia gingrina* sp. nov., in which the cirrus is much less robust. This species has a very large copulatory bulb.

In the gut of one specimen, QMG220695, was found an intact specimen of *Temnosewellia bacrioniculus* sp. nov. that was subsequently identified and registered as QMG220865. This predator-prey relationship between two species of *Temnosewellia* spp. on an individual host hints at the complex ecological interactions observed by Cannon & Jennings (1987) to occur between different temnocephalan species and genera on *Cherax* crayfish hosts. The discovery also highlights the potential need for care to avoid contamination of worm tissue used for DNA analysis.

Temnosewellia aspra sp. nov.
(Fig. 28A–C)

ETYMOLOGY. From *aspros* = white (Greek); a reference to the colour of this non-pigmented worm.

MATERIAL. HOLOTYPE: QMG220436 (WM), from *Euastacus balanensis* [QMW26587], Mt Haig, Kairi Ck trib., Lamb Ra. SF, Qld (17°06.0'S 145°35.5'E), 3.06.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un. PARATYPES: QMG220437–220438 (WM), 100% alc/Un; [QMW17241 & QMW26677], QMG220439–220440 (WM), 27.09.1990, L.R.G. Cannon & K.B. Sewell, Form-Acetic/Hx. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26587], QMG220441–220442 (WM), 3.06.2002, D. Blair, D. Hansman, K.B. Sewell & M.S. Bryant, 100% alc/Un; QMG220443–220446 (CP), 100% alc/Fau.

DESCRIPTION. Characteristics of genus but lacking body pigment. Selected body measurements of type specimens from *Euastaeus balanensis* are: QMG220436 (H): B(1073 × 626), LE(715), PH(203 × 268), SD(285), PD(138); QMG220437 (P): B(967 × 545), LE(659), PH(179 × 236), SD(244), PD(138); QMG220438 (P): B(1285 × 634), LE(715), PH(179 × 276), SD(293), PD(138); QMG220439 (P): B(1714 × 775), LE(1000), PH(245 × 367), SD(357), PD(173); QMG220440 (P): B(1106 × 764), LE(740), PH(179 × 252), SD(193), PD(130).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped; distal opening very oblique, often folded into hourglass or irregular shape. Swelling near-even, extends proximally well past introvert base on both sides, further on longer side. Selected cirrus measurements of specimens from *Euastaeus balaneusis* from type locality are: QMG220443: S(191 × 43), I(51 × 10), IS(106 × 69); QMG220444: S(191 × 45), I(55 × 10), IS(118 × 75); QMG220445: S(189 × 49), I(70 × 9), IS(106 × 73); QMG220446: S(191 × 45), I(59X 10), IS(96 × 73).

HOST. *Euastacus balanensis*.

DISTRIBUTION. North-eastern Qld — from the Atherton Tableland region, W of Cairns, at Kairi Ck, Mt Haig.

REMARKS. The cirrus is similar to that of *Temnosewellia albata* sp. nov., though smaller, and to *T. aphyodes* sp. nov. and *T. argeta* sp. nov., being larger than *T. aphyodes* sp. nov. and with an opening of the introvert more oblique than *T. argeta* sp. nov.

Temnosewellia bacrio sp. nov.
(Fig. 29A–C)

ETYMOLOGY. From *bacrio* = ladle, long handled vessel (Latin, masculine); a reference to the shape of the cirrus.

MATERIAL. HOLOTYPE: QMG220630 (WM), from *Euastacus sulcatus* [QMW26658], upper Tallebudgera Ck, at 'Fern Gully' (28°13.7'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un. PARATYPES: QMG220631–220632 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220633–220634 (CP), 100% alc/Fau. OTHER MATERIAL. From *Euastacus maidae*. Qld: [QMW26632], QMG220635–220637 (WM), upper Currumbin Creek, upstream of old sawmill, 2km E of Mt Cougal (28°14.3'S 153°20.8'E), 11.01.1992, L.R.G. Cannon, K.B. Sewell & J.W. Short, HW/Form/Hx; QMG220638–220639 (WM), Form/Hx; QMG220640 (WM), HW/Form/Hx; QMG220641–220646 (WM) HW/Form/Fau; QMG220647 (LS[3]), Form/H&E; QMG220648–220650 (LS[3,4,2]), HW/Form/H&E.

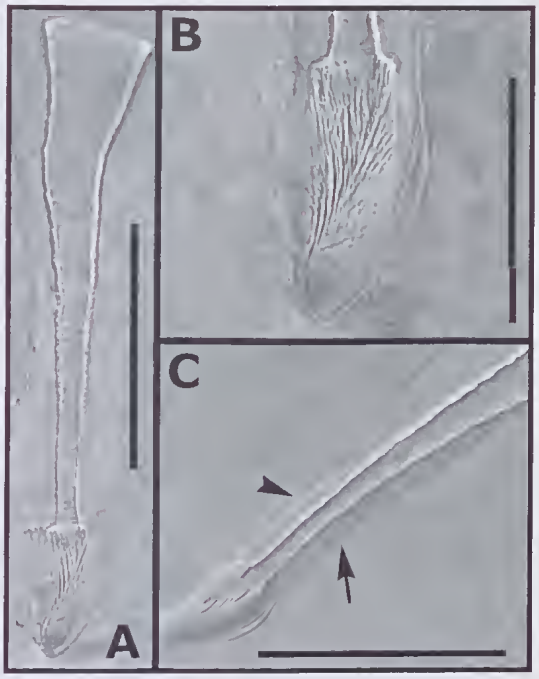


FIG. 28. *Temnosewellia aspra* sp. nov. A–C. Nomarski interference contrast photomicrographs of Faure's preparations from *Euastacus balanesis*. A, QMG220446, whole cirrus, scale = 100μm; B, QMG220446, introvert, scale = 50μm; C, QMG220444, introvert distal region showing introvert swelling on the introvert shorter side (arrowhead) and longer side (arrow), scale = 100μm.

From *Euastacus valentulus*. Qld: [QMW26667], QMG220694 (WM), upper Tallebudgera Ck, at 'Fern Gully' (28°13.7'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus sulcatus* are: QMG220630 (H): B(1650 × 797), LE(1098), PH(236 × 285), SD(480), PD(203); QMG220631 (P): B(1829 × 1309), LE(1382), PH(244 × 390), SD(569), PD(236); QMG220632 (P): B(1602 × 919), LE(1098), PH(358 × 285), SD(472), PD(211).

Reprodnetive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped; distal opening

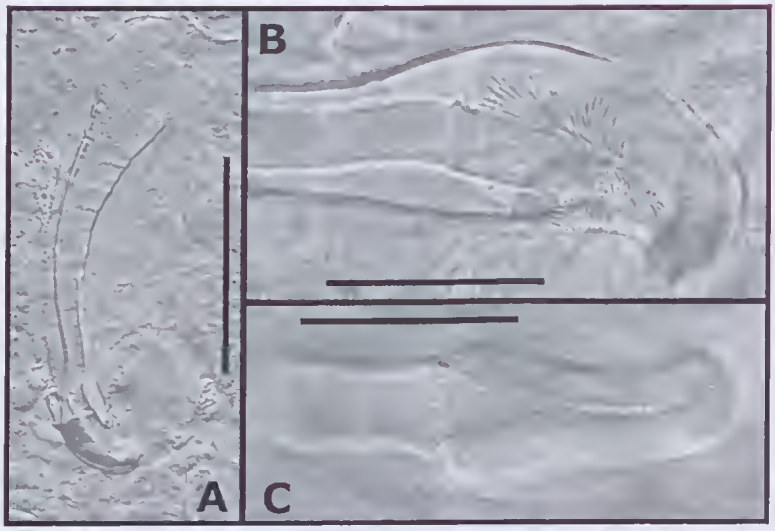


FIG. 29. *Temnosewellia bacrio* sp. nov. A–C, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220641 from *Euastacus maidae,* whole cirrus, scale = 200µm; B, QMG220641, introvert distal region, scale = 50µm; C, QMG220634 from *Euastacus sulcatus,* introvert distal region, scale = 50µm.

very oblique, often folded into hourglass or irregular shape. Swelling uneven, extends proximally well past introvert base, about equally on each sides. Selected cirrus measurements of specimens from *Euastacus sulcatus* from type locality are: QMG220630 [WM]: S(228 × 47), I(98 × 18), IS(81 × 85); QMG220631 [WM]: S(217 × 57), I(96 × 20), IS(81 × na); QMG220633 [juvenile]: S(116 × 28), I(93 × 22), IS(61 × 53); QMG220634 [juvenile]: S(41 × 22), I(100 × 20), IS(na × na).

HOSTS. *Euastacus maidae, E. sulcatus, E. valentulus.*

DISTRIBUTION. South-eastern Qld — from the Macpherson Ra. region, in the area near Mt Cougal, at upper Currumbin Ck and upper Tallebudgera Ck.

REMARKS. The body pigment is well developed even in small juvenile specimens. The cirrus is most similar to that of *Temnosewellia bacrioniculus* sp. nov. but is overall larger and less funnel-shaped. Furthermore the introvert swelling is uneven in *Temnosewellia bacrio* sp. nov., but in *T. bacrioniculus* sp. nov. it is even. *Temnosewellia bacrio* sp. nov. was found on three different host species collected on the same day from the same small pool on Upper Tallebudgera Ck. This is evidence that the worms readily switch crayfish hosts.

Temnosewellia bacrioniculus sp. nov. (Fig. 30A–E)

ETYMOLOGY. From *bacrio* = ladle, long-handled vessel (Latin, masculine, diminutive); a reference to the shape of the cirrus and its small size.

MATERIAL. HOLOTYPE: QMG220651 (WM), from *Euastacus neohirsutus* [QMW26636], Little Nymboida R., junction of Lowanna and Coramba Rds, Bindarri NP, NSW (30°14.0'S 152°55.3'E), 16.03.2002, K.B. Sewell, 100% alc/Un. PARATYPES: QMG220652–220655 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220656–220658 (CP), 100% alc/Fau. OTHER MATERIAL. From *Euastacus maidae.* Qld: [QMW25590], QMG220659–220664 (WM), Tallebudgera Ck trib., Tallebudgera Valley, near '1000m mark on main track' (28°14.0'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.R.G. Cannon, K.B. & S.G. Sewell, hot Bouin/Un; QMG220665 (CP), 100% alc/Un; QMG220667–220669 (CP), hot Form/Fau; QMW220670–220672 (CP) Fau; [QMW26632], QM 220666 (CP) upper Tallebudgera Ck, at 'Fern Gully' (28°13.7'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.R.G. Cannon, K.B. & S.G. Sewell, 100% alc/Un.

From *Euastacus setosus.* Qld: [QMW26648], QMG220673–220676 (WM), Greenes Falls, at first creek junction downstream from top falls, Maiala NP (27°19.4'S 152°45.8'E), 25.02.1991, L.R.G. Cannon & K.B. Sewell, HW/Form-Acetic/Hx; QMG220677 (WM), HW/Bouin/Hx; QMG220678–220680 (CP) HW/Form-Acetic/Fau; QMG220681 (CP) HW/Bouin/Fau; QMG220682 (LS[2]), HW/Form-Acetic/Fau; QMG220683 (LS[2]) HW/Bouin; QMG220684–220686 (LS[2,2,2,]), HW/Form-Acetic/Fau; [QMW26649] QMG221163–221164 (CP), 1.10.2002, K.B. Sewell & S.G. Sewell, 100% alc/Fau.

From *Euastacus sulcatus.* Qld: [QMW26658], QMG220687–220688 (CP), upper Tallebudgera Ck, at 'Fern Gully' (28°13.7'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un.

From *Euastacus valentulus.* Qld: [QMW26667], QMG220865 (CP), upper Tallebudgera Ck, at 'Fern

Gully' (28°13.7'S 153°18.5'E) [removed from the gut of QMG220695; see remarks below], 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un.

DESCRIPTION. Showing characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus neohirsutus* are: QMG220651 (H): B(1992 × 870), LE(1309), PH(366 × 467), SD(488), PD(203); QMG220652 (P): B(1650 × 837), LE(1057), PH(325 × 415), SD(366), PD(138); QMG220653 (P): B(1569 × 854), LE(1089), PH(293 × 431), SD(350), PD(187); QMG220654 (P): B(1693 × 1016), LE(1114), PH(313 × 488), SD(463), PD(179); QMG220655 (P): B(1789 × 894), LE(1220), PH(276 × 447), SD(415), PD(179).

Reproductive System. Female. Vagina: Weakly sclerotised at distal extremity.

Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped; distal opening very oblique, often folded into hourglass or irregular shape. Swelling even, extends proximally well past introvert base about equally so on each side. Selected cirrus measurements of specimens from *Euastacus neohirsutus* from type locality are: QMG220656: S(203 × 79), I(59 × 13), IS(65(?) x na); QMG220657: S(207 × 91), I(59 × 13), IS(81(?) × 65(?)); QMG220658: S(197 × 71), I(57 × 13), IS(na × na).

FIG. 30. *Temnosewellia bacrioniculns* sp. nov. A–E, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220656, from *Euastacus neohirsutus*, whole cirrus, scale = 100µm; B, QMG221163 from *E. setosus*, whole cirrus, scale = 250µm; C, QMG220658, from *E. neohirsutus*, weakly sclerotised vagina, cirrus tip (arrowhead), scale = 50µm; D, QMG220656 from *E. neohirsutus*, introvert distal region with the oblique distal opening folded into an 'hourglass shape', scale = 50µm; E, QMG221163 from *E. setosus*, introvert distal region with the oblique distal opening not folded into either an 'irregular' or 'hourglass shape', scale = 50µm.

HOSTS. *Euastacus maidae, E. neohirsutus, E. setosus, E. sulcatus, E. valentulus.*

DISTRIBUTION. South-eastern Qld — from the the Macpherson Ra. region, near Mt Cougal; and from the D'Aguilar Ra., at Greenes Falls, near Mt Glorious. North-eastern NSW — from Bindarri NP, at Little Nymboida R., near Lowanna.

REMARKS. The cirrus of this species is most similar to that of *Temnosewellia bacrio* sp. nov. but is smaller and more funnel-shaped. The dimensions of the introvert swelling were difficult to determine confidently. It is a relatively widespread species that shows some slight regional variation. The type specimens from Little Nymboidea River NSW have a slightly smaller cirrus and slightly more body pigment than the Qld specimens. Small mature worms less than 2mm body length from the type locality

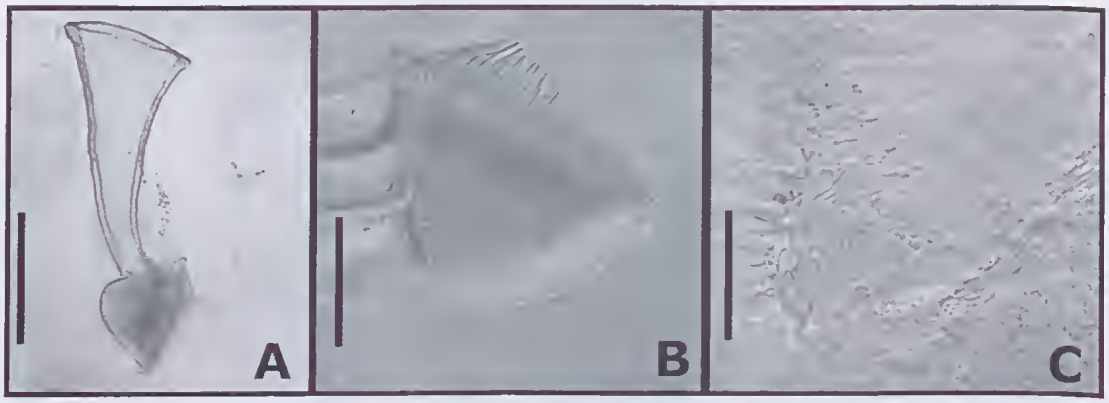


FIG. 31. *Temnosewellia batiola* sp. nov. from *Euastacus hystricosus*. A–C, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220497, whole cirrus, scale = 250µm; B, QMG220497, introvert distal region, scale = 100µm; C, QMG220497, weakly sclerotised vagina, scale = 100µm.

typically had well developed body pigment. Although not nearly as obvious as with members of *Temnohaswellia*, the outer vagina does show some weak sclerotisation.

The Faure's mounted specimen of *Temnosewellia bacrioniculus* sp. nov (QMG220865) examined here was collected intact from the gut of *T. aspinosa* sp. nov. (QMG220695) that was obtained from the host *Euastacus valentulus* [QMW26667]. The latter host was collected in the same pool as *E. sulcatus* [QMW26658].

Temnosewellia batiola sp. nov.
(Fig. 31A–C)

ETYMOLOGY. From *batiola* = goblet (Latin, feminine); a reference to the large goblet-shaped introvert.

MATERIAL. HOLOTYPE: QMG220488 (WM), from *Euastacus hystricosus* [unreg. host, ident. Dr Mark Ponniah, Griffith University] Stony Ck, Stony Ck SF, Qld (26°51.7'S 152°44.0'E) 26.03.1992, M. Ponniah, 100% alc/Un. PARATYPES: QMG220489–220491 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY. QMG220492 (WM), 100% alc/Un; QMG220493–220498 (CP), 100% alc/Fau. OTHER MATERIAL. From *Euastacus hystricosus*. Qld: [QM 6461] QMG220499–220501 (WM), Booloumba Ck, Conondale Ra. (26°39.0'S 152°38.7'E), 29.11.1974, G.B. Monteith & S.R. Monteith., 70% alc/Hx; QMG220502–220504 (LS[3,7, 18]). 70% alc/H&E; [unreg. host] QMG220505–220506 (WM), Booloumba Ck, Conondale Ra. 29.11.1973, N. Gillespie, 70% alc(?)/Hx; QMG220507–220510 (LS[10,7,19,8]) 70% alc(?)/Hx; [unreg. host], QMG220511 (WM), Booloumba Ck, 'beauty spot 100', Conondale Ra. (26°39'S 152°39'E), 18.06.1986, 70% alc(?)/Hx; [QMG26628], QMG221165–221166 (CP), Booloumbah Ck, at road crossing near Booloumbah Falls car park, Conondale NP (26°41.2'S 152°37.1'E), 29.09.2002, D. Blair & K.B. Sewell, 100% alc/Fau; [unreg. host], QMG220517 (CP) Little Yabba Ck, Conondale SF, 17.11.1983, L.R.G.Cannon & J.B. Jennings, Bouin/Fau; QMG220512–220516, 220518–220523 (LS[1,1 ,2,7,1,5,3,13,8,8,1]), Bouin/H&E.

From *Euastacus urospinosus*. Qld: [QMW27489], QMG221210, 221212 (CP), Kondalilla NP, Skene Ck trib. at service rd concrete causeway nr NP boundary (26°40.5'S 152°52.1'), 12.01.2004, D. Blair & R.D. Sewell, alc/Fau; [QMW27499], QMG221211, (CP), alc/Fau.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus hystricosus* are: QMG220488 (H): B(4998 × 2795), LE(3774), PH(632 × 1122), SD(1367), PD(551); QMG220489 (P): B(5814 × 3978), LE(4284), PH(836 × 1530), SD(1530), PD(632); QMG220490 (P): B(2713 × 1306), LE(1775), PH(306 × 500), SD(593), PD(333); QMG220491 (P): B(4529 × 2958), LE(3468), PH(428 × 1040), SD(1204), PD(571).

Reproductive System. Female. Vagina: Weakly sclerotised at distal extremity, resembling crumpled tissue paper.

Male. Cirrus: Shaft cone-shaped. Introvert goblet-shaped; distal opening oblique. Swelling slightly uneven, extends proximally well past introvert base on both sides, slightly further on longer side. Selected cirrus measurements of specimens from *Euastacus hystricosus* from type locality are: QMG220493: S(532 × 298),

I(242 × 62), IS(242 × 198); QMG220494: S(504 × 226), I(210 × 56), IS(242 × 181); QMG220495: S(431 × 169), I(242 × 65), IS(206 × 169); QMG220496: S(423 × 250), I(227 × 65), IS(254 × 190); QMG220497: S(492 × 250), I(238 × 60), IS(214 × 181).

HOSTS. *Euastacus hystricosus*, *E. urospinosus*

DISTRIBUTION. South-eastern Qld — from the Conondale Ra. region, in the areas W of Maleny and Beerwah.

REMARKS. This species is large, with some specimens examined close to 6mm body length. The cirrus is extremely large and robust. The numerous thin spines of the distal introvert that protrude from the distal opening give the inverted introvert an appearance reminiscent of the flower of a scotch thistle, e.g. *Onopordum acanthium*.

The cirrus is similar to that of *Temnosewellia fasciata* but there are several distinguishing characters. The longer side of the introvert of *Temnosewellia batiola* sp. nov. is longer and the shorter side is shorter than in the introvert of *T. fasciata*. Thus, the relative differences between the longer and shorter sides of the introvert are considerably more in *T. batiola* sp. nov. and the distal opening is more oblique as a consequence. The introvert thickening of *Temnosewellia batiola* sp. nov. extends less distance proximally past the introvert base, and the distal shaft lacks the collar of tissue observed in *T. fasciata*. The vagina is weakly sclerotised distally, but not as markedly as in members of the genus *Temnohaswellia*.

Temnosewellia belone sp. nov.
(Fig. 32A–B)

ETYMOLOGY. From *belone* = arrowhead, dart or needle (Greek, feminine); a reference to the arrowhead shaped distal region of the male organ.

MATERIAL. HOLOTYPE: QMG221135 (WM), from *Euastacus brachythorax* [[QMG26593], Rutherford Ck crossing on Niten Rd, Brown Mtnn, Glenbog SF, NSW (36°36.4'S 149°24.4'E), 18.03.2002, K.B. Sewell, 100% alc/Un. PARATYPES: [QMG26592], QMG221136 (WM), 13.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/MB/Hx; QMG221137–221138 (WM), HW/Form/Hx; [QMG26593], QMG221139 (WM), 18.03.2002, K.B. Sewell, 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: [QMG26593], QMG221140–221143 (WM), 18.03.2002, K.B. Sewell, 100% alc/Un; QMG221144–221149 (CP), 100% alc/Fau; [AMP 34055], AMW28695 (WM), Rutherford Ck

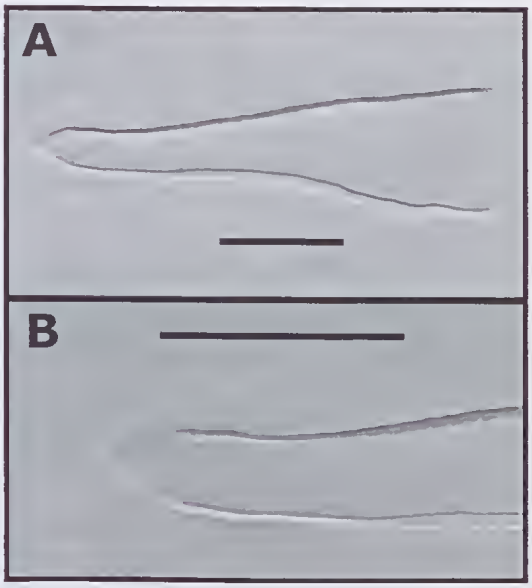


FIG. 32. *Temnosewellia belone* sp. nov. from *Euastacus brachythorax*. A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG221145, whole cirrus, scale = 50µm; B, QMG221145, introvert distal region, scale = 50µm.

trib., Brown Mtn Flora Reserve, (36°35'S 149°23'E) 2.11.1981, G.I. Morgan & S.J. Harders, 70% alc(?)/Hx.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus brachythorax* are: QMG221135 (H): B(4468 × 2693), LE(3080), PH(683 × 992), SD(1408), PD(569); QMG221136 (P): B(3733 × 1918), LE(2448), PH(490 × 745), SD(918), PD(439); QMG221137 (P): B(4264 × 2020), LE(2978), PH(551 × 734), SD(857), PD(408); QMG221138 (P): B(3060 × 1183), LE(1856), PH(390 × 439), SD(378), PD(167); QMG221139 (P): B(3305 × 2550), LE(2530), PH(592 × 908), SD(1102), PD(408).

Reproductive System Male. Cirrus: Shaft cone-shaped. Introvert lacks spined region but has striated, apical, pointed structure (about 20 long) attached to introvert base. Swelling not observed [absent?]. Selected cirrus measurements of specimens from *Euastacus brachythorax* from type locality are: QMG221145: S(175 × 51), I(19 × 17), IS(na × na); QMG221146: S(126 × 43), I(19 × 16), IS(na × na); QMG221147: S(159 × 55), I(18 × 13), IS(na × na); QMG221149: S(152 × 55), I(21 × 18), IS(na × na).

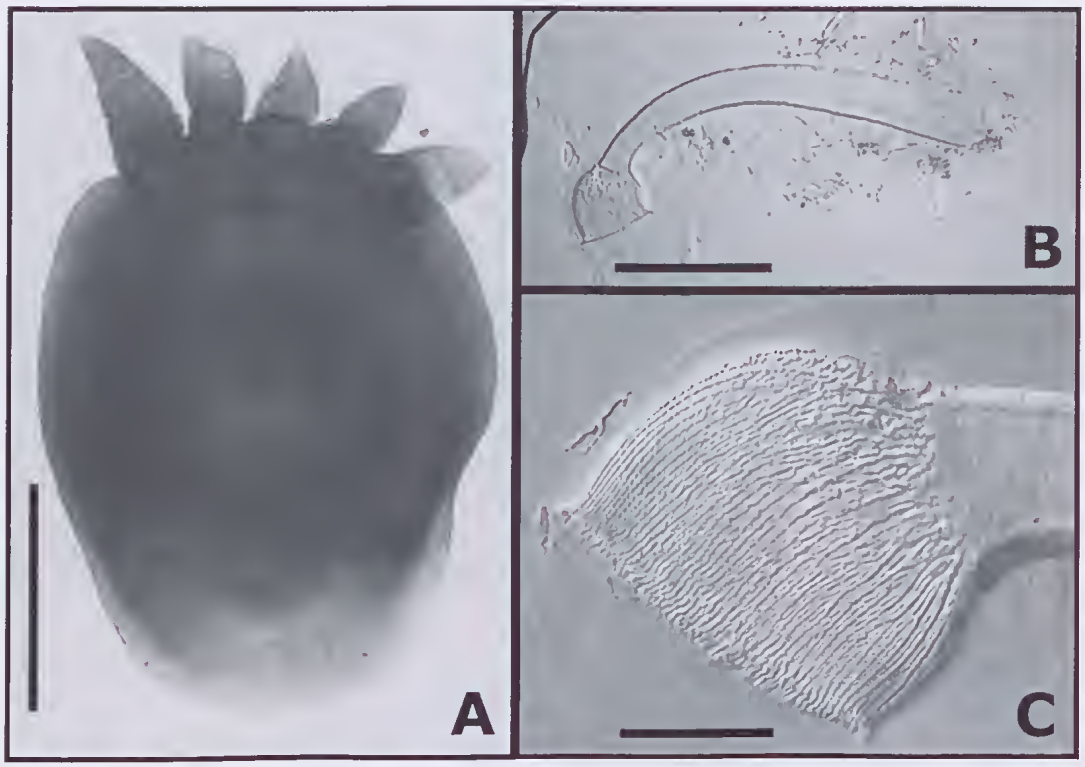


FIG. 33. *Temnosewellia caliculus* sp. nov. from *Euastacus kershawi*. A, QMG220901, whole worm (Holotype) showing pigment, scale = 1mm; B–C, Nomarski interference contrast photomicrographs of Faure's preparations; B, QMG220903, whole cirrus, scale = 250μm; C, QMG220903, introvert distal region, scale = 50μm.

HOST. *Euastacus brachythorax*.

DISTRIBUTION. From the region of Brown Mtn, W of Bemboka, SE NSW.

REMARKS. The vagina is of this species is very weakly sclerotised. The cirrus resembles that of *Temnosewellia apiculus* sp. nov. except that that the cirrus is overall much smaller in *T. belone* sp. nov. and more dagger-like in outline. The tooth-like structure has longitudinal striations which are possibly homologues of the ridges of spines that are typically found in other species. Neither spines nor introvert swelling were observed for this species.

Temnosewellia caliculus sp. nov.
(Fig. 33A–C)

ETYMOLOGY. From *calix* = a little goblet or cup (Latin, masculine, diminutive); a reference to the shape of the introvert.

MATERIAL. HOLOTYPE: QM 220901 (WM), from *Euastacus kershawi* [unreg. host, ident. Dr Susan Lawler, Latrobe University, VIC], Wongungarra R., (37°22'S 147°11'E), Jul. 2000, S.H. Lawler, hot Form/Un. PARATYPE: QM 220902 (WM), hot Form/Un. OTHER MATERIAL FROM TYPE LOCALITY: QM 220903–220906 (CP), Fau. OTHER MATERIAL. From '*freshwater cray*' [=*Euastacus woiwurii*?] VIC: [unreg. host], NMVF 93809–93810, (CP), Fern Tree Gully (37°53'S 145°18'E), 18.02.1872, unknown fixation/Fau.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus kershawi* are: QMG220901(H): B(2978 × 2040), LE(2326), PH(439 × 577), SD(1071), PD(490); QMG220902(P): B(3835 × 1632), LE(2591), PH(488 × 467), SD(918), PD(428).

Reproductive system. Male. Cirrus: Shaft cone-shaped. Introvert goblet-shaped; distal opening oblique. Swelling uneven, extends proximally far past introvert base on longer side, not observed on shorter side.Selected cirrus measurements of specimens from *Euastacus kershawi* from type locality are: QMG220903: S(671 × 91), I(142

× 63), IS(na × na); QMG220904: S(665 × 77), I(134 × 51), IS(na × na); QMG220905: S(630 × 102), I(136 × 66), IS(na × na).

HOSTS. *Euastacus kershawi*, 'fresh water cray' probably either *E. woiwuru*? or *E. yarraensis*? (see Remarks).

DISTRIBUTION. VIC — from the east Melbourne region; and from the Wongungarra R. region.

REMARKS. The body pigment in some specimens of this species is connected to the pigment in the region of the eyes in single large tracts which are thicker than those observed for other species (Fig. 33A). The large cirrus is similar broadly to those of species such as *Temnosewellia fasciata* with a prominent goblet shaped introvert. However, the cirrus has a relatively longer and narrower shaft somewhat reminiscent of that in *Temnosewellia cypellum* sp. nov. The latter species is distinct in having the unique character of the longer side of the introvert on the shorter side of the shaft. Based on the approximate ranges of *Euastacus* species presented by Morgan (1986), the host listed as '*freshwater cray*' is most likely to be either *E. woiwuru* or *E. yarraensis* (pers. comm. Dr Susan Lawler, Latrobe University, VIC,). We did not find this species on *Euastacus woiwuru* we collected at Fern Tree Gully.

Temnosewellia cestus sp. nov.
(Fig. 34A–B)

ETYMOLOGY. From *caestus* = boxer's glove (Latin, masculine); a reference to the introvert resembling a boxing glove.

MATERIAL. HOLOTYPE: QMG220524 (WM), from *Euastacus urospinosus* [QMW26665] Kondalilla Falls NP, at first creek from park entrance along walking track, Qld (26°41'S 152°52'E) 28.03.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx. PARATYPES: QMG220525 (WM), HW/Form/Hx; QMG220526–220527 (WM) Form/Hx. OTHER MATERIAL FROM TYPE LOCALITY: QMG220528–220529 (WM) Form/Un; QMG220530–220533 (CP) HW/Form/Fau; QMG220534–220536 (LS[3,2,1]) Form/H&E. OTHER MATERIAL. From *Euastacus urospinosus*. Qld: [QMW24670], QMG220537–220538 (WM), Conondale Area on Maleny to Kenilworth Rd. nr property of J.F. & I.B. Sparshott (26°45'S 152°45'E), 19.07.1998, P.E., K.M. & J.F. Sparshott, hot Form/Un; QMG220539 (CP), 100% alc/Fau; QMG220540–220541 (CP), HW/Fau; [QMW26664], QMG220542 (WM), Mary Cairncross NP, Maleny, to right of walking track, 200m from park entrance (26°46.6'S 152°52.8'E), 28.03.1991, L.R.G. Cannon &.K.B. Sewell, HW/Form/Hx. From *Cherax dispar* [unreg. host, ident. KBS] QMG221214 (CP), Booloumbah Ck, at road crossing near Booloumbah Falls car park, Conondale NP (26°41.2'S 152°37.1'E), 12.01.2004, D. Blair & R.D. Sewell, alc/Fau.

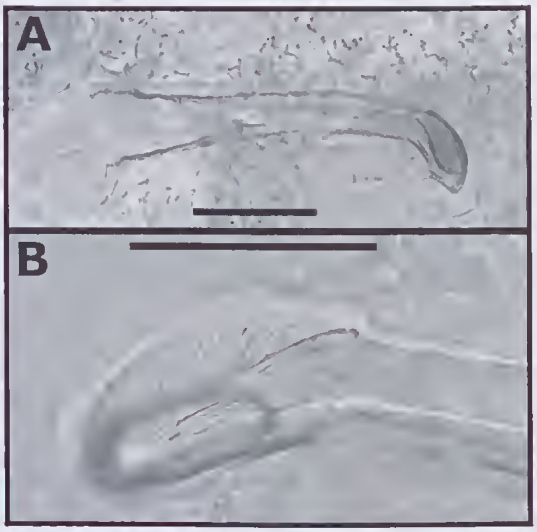


FIG. 34. *Temnosewellia cestus* sp. nov. from *Euastacus urospinosus*. A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220530, whole cirrus, scale = 100μm; B, QMG220539, introvert distal region, scale = 50μm.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus urospinosus* are: QMG220524 (H): B(2472 × 1171), LE(1667), PH(341 × 504), SD(528), PD(244); QMG220525 (P): B(2089 × 1057), LE(1431), PH(309 × 423), SD(407), PD(203); QMG220526 (P): B(2938 × 1591), LE(2101), PH(388 × 673), SD(816), PD(347); QMG220527 (P): B(1979 × 1693), LE(1714), PH(388 × 704), SD(734), PD(347).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop shaped; distal opening very oblique. Swelling near-even, extends proximally well past introvert base, about equal on both sides. Selected cirrus measurements of specimens from *Euastacus urospinosus* from type locality are: QMG220530: S(262 × 69), I(91 × 22), IS(na × na); QMG220531: S(175 × 39), I(93 × 22), IS(na × na); QMG220532: S(112 × 20), I(85 × 20), IS(na × na).

Selected cirrus measurements of other specimens from *Euastacus urospinosus* are: QMG220539: S(346 × 104), I(85 × 20), IS(118 × 93); QMG220540: S(352 × 102), I(85 × 18),

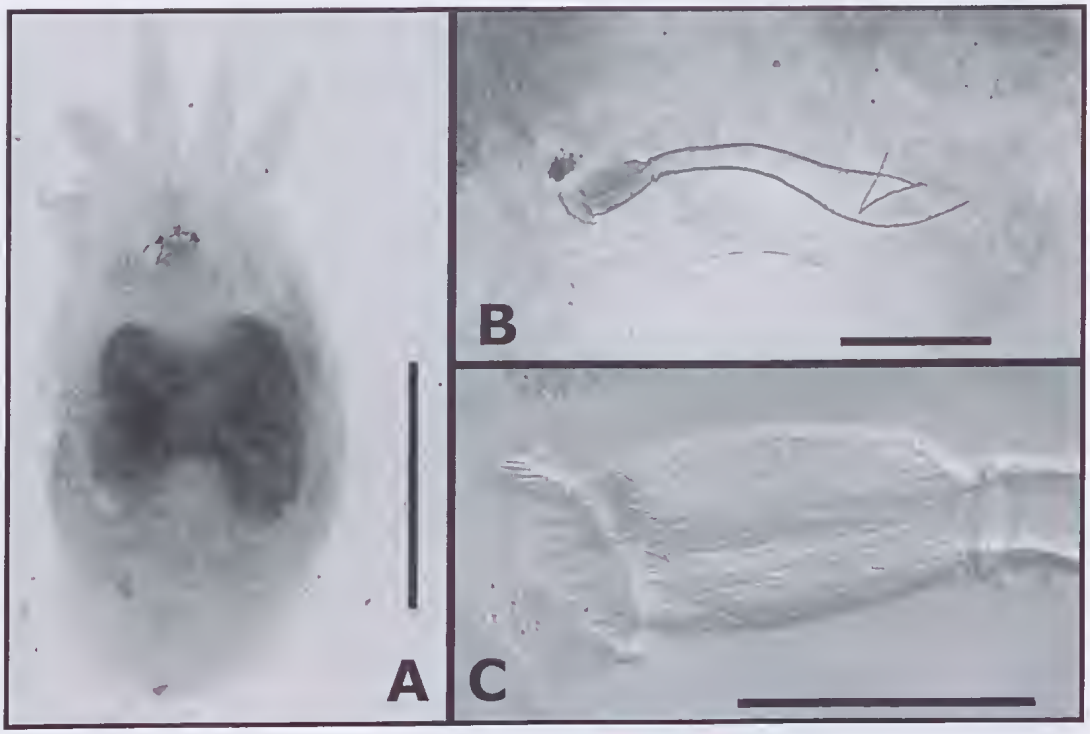


FIG. 35. *Temnosewellia comythus* sp. nov. from *Euastacus gumar*. A, QMG220824, whole worm (Holotype) showing pigmention pattern, scale = 1mm; B–C. Nomarski interference contrast photomicrographs of Faure's preparations; B, QMG220832, whole cirrus, scale = 250µm; C, QMG220832, introvert distal region, scale = 100µm.

IS(169 × 154); QMG220541: S(289 × 71), I(85 × 18), IS(138 × 148).

HOST. *Cherax dispar, Euastacus urospinosus*.

DISTRIBUTION. South-eastern Qld — from the Blackall Ra., at Kondallila Falls, near Flaxton; and from the Conondale Ra. region, near Maleny.

REMARKS. The largest specimens examined were about 4mm body length and had well developed but sparse dorsal body pigment that was not arranged in a close woven network. Adult worms about 2mm body length have only a slight concentration of pigment in the eye region and thus appear pale to the naked eye. The arrangement of large spines on the longer side of the introvert give the inverted introvert an appearance reminiscent of a boxing glove. The general shape of the cirrus resembles that of *Temnosewellia bacrioniculus* sp. nov. and especially *T. bacrio* sp. nov., but it is much larger.

The record of *Temnosewellia cestus* from a species of *Cherax* probably indicates an accidental host as in this locality both species of *Cherax* and *Euastacus* co-occur, a situation that is rarely found. Nevertheless, we acknowledge that much is still to be learned of the eclogy of these worms.

Temnosewellia comythus sp. nov. (Fig. 35A–C)

ETYMOLOGY. From *komys* = bundle or sheaf (Greek); a reference to the appearance of the cirrus introvert.

MATERIAL. HOLOTYPE: QMG220824 (WM), from *Euastacus gumar* [QMW26662], Culmaron Ck, Richmond Ra. NP (28°50.5'S 152°44.1'E), 4.03.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, hot Bouin/Un. PARATYPES: QMG220825–220828 (WM), hot Bouin/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220829 (WM), hot Bouin/Un; QMG220831–220832 (CP), 100% alc/ Fau. QMG220833–220839 (CP), Fau. OTHER MATERIAL. From *Euastacus gumar*. NSW: [QMW5666], QMG220830 (WM) Richmond Ra., 19.04.1976, R. Raven, 70% alc(?)/Hx.

From *Euastacus spinichelatus*. NSW: [QMW26652], QMG220840–220841 (WM), Joyces Ck, Oxley Hwy

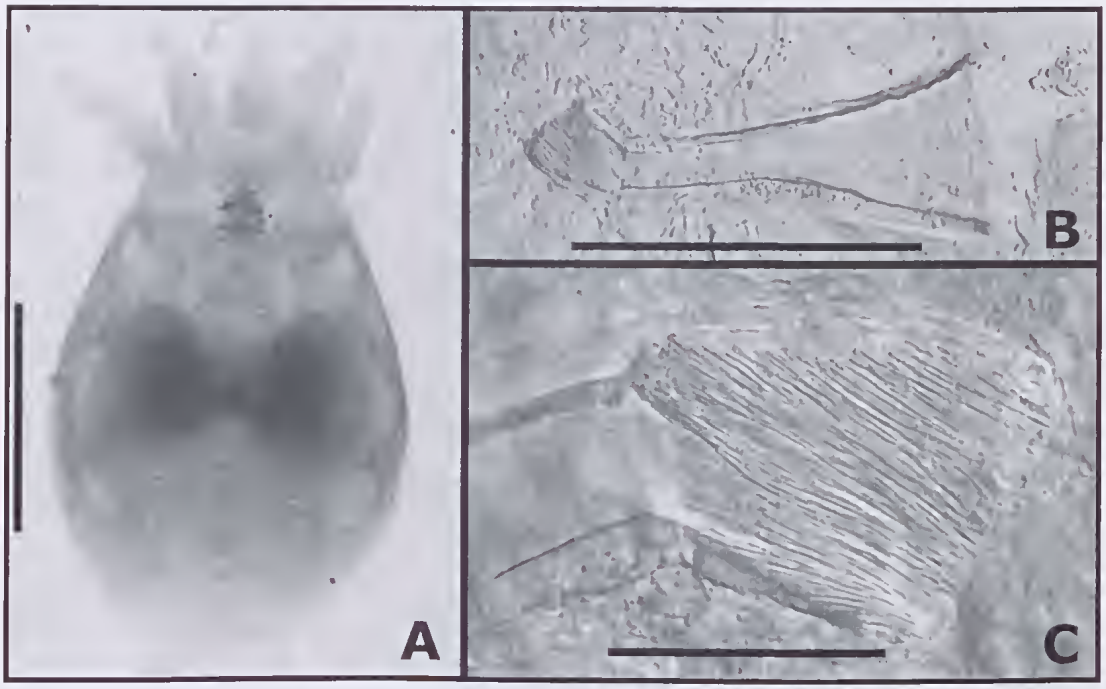


FIG. 36. *Temnosewellia coughrani* sp. nov. from *Euastacus sulcatus*. A–C, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220555, whole worm (Paratype) showing pigmention pattern, scale = 1mm; B, QMG220570, whole cirrus, scale = 250µm; C, QMG220570, introvert distal region, scale = 50µm.

crossing, 6km SE of Yarrowitch, Enfield SF (31°16.7'S 151°58.3'E), 8.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; [QMW26653], QMG220842–220845 (WM), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26652], QMG220846–220849, 8.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; [QMW26653], QMG220850 (WM), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26652], QMG220851–220852, 8.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Fau; QMG220853–220857 (CP), Fau; [QMW26653], QMG220858–220859 (LS[4,5]), 23.10.1991, L.R.G. Cannon & K.B. Sewell, Bouin/H&E.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus gumar* are: QMG220824 (H): B(2509 × 1132), LE(1734), PH(402 × 423), SD(447), PD(252); QMG220825 (P): B(2305 × 1510), LE(1632), PH(471 × 447), SD(496), PD(244); QMG220826 (P): B(2795 × 1224), LE(1856), PH(411 × 382), SD(528), PD(252); QMG220827 (P): B(2183 × 1418), LE(1469), PH(317 × 439), SD(537), PD(244); QMG220828 (P): B(1734 × 836), LE(1153), PH(333 × 289), SD(415), PD(187).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert cylinder to scoop-shaped; distal opening slightly oblique. Swelling slightly uneven, extends proximally far past introvert base, further on longer side. Selected cirrus measurements of specimens from *Euastacus gumar* from type locality are: QMG220831: S(486 × 150), I(175 × 39), IS(299 × 179); QMG220832: S(557 × 163), I(163 × 41), IS(350 × 220); QMG220833: S(447 × 136), I(148 × 41), IS(295 × 193); QMG220835: S(407 × 142), I(175 × 41), IS(191 × 207); QMG220838: S(394 × 81), I(175 × 39), IS(266 × 191).

HOSTS. *Euastacus gumar, E. spinichelatus*.

DISTRIBUTION. North-eastern NSW — from the Richmond Ra. region at Cumaron Ck; and from Enfield SF, near Yarrowitch, at Joyces Ck.

REMARKS. Smaller mature worms of this species have dense pigment concentrated only in the region around the eyes. As the worms become larger the pigment develops to become the typical dense woven tracery across the dorsal surface. The cirrus is large and in fixed specimens is typically folded over and creased on the longer

side of the proximal shaft (Fig. 36B). The cirrus resembles that of *Temnosewellia fax* sp. nov., though is larger and, like *T. fax* sp. nov., the introvert is not goblet shaped. However, the introvert of *Temnosewellia comythus* sp. nov. is relatively longer in comparison to the shaft than in *T. fax* sp. nov., and the opening is oblique.

Temnosewellia coughrani sp. nov.
(Fig. 36A–C)

ETYMOLOGY. For Jason Coughran who assisted greatly with the location and capture of hosts from which the first specimens were recognised.

MATERIAL. HOLOTYPE: QMG220554 (WM), from *Euastacus sulcatus* [QMW26655], Bundoozle Flora Reserve, Richmond Ra. NP, NSW (28°36.4'S 152°44.0'E), 4.03.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, 100% alc/Un. PARATYPES: QMG220555–220556 (WM), 100% alc/Bouin/Un; QMG220557–220558 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220559 (WM), 100% alc/Bouin/Un; QMG220560–220562 (WM), 100% alc/Un; QMG220563–220566 (CP), 100% alc/Fau; QMG220567–220569 (WM), Fau; QMG220570–220572 (CP), 100% alc/Bouin/Fau. OTHER MATERIAL. From *Euastacus nirangudjin*. NSW: [QMW26633], QMG220573–220577 (WM), Ironpot Ck, Toonumbar NP (28°29.9'S 152°44.0'E), 4.03.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, 100% alc/Un; QMG220578–220580 (CP), 100% alc/Fau.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus sulcatus* are: QMG220554 (H): B(2672 × 1408), LE(2020), PH(571 × 530), SD(734), PD(306); QMG220555 (P): B(2856 × 1652), LE(1999), PH(510 × 612), SD(694), PD(316); QMG220556 (P): B(2448 × 1530), LE(1775), PH(490 × 561), SD(551), PD(245); QMG220557 (P): B(2591 × 1550), LE(1693), PH(592 × 571), SD(694), PD(316); QMG220558 (P): B(2754 × 1469), LE(1958), PH(510 × 571), SD(592), PD(326).

Reproductive Sytem. Male. Cirrus: Shaft cone-shaped. Introvert scoop-shaped; distal opening oblique. Swelling not observed. Selected cirrus measurements of specimens from *Euastacus sulcatus* from type locality are: QMG2220565: S(266 × 144), I(85 × 30), IS(na × na); QMG2220566: S(230 × 128), I(83 × 30), IS(na × na); QMG2220569: S(240 × 110), I(81 × 28), IS(na × na); QMG2220570: S(266 × 128), I(85 × 30), IS(na × na); QMG2220571: S(238 × 130), I(81 × 28), IS(na × na).

HOSTS. *Euastacus nirangudjin, E. sulcatus*.

DISTRIBUTION. North-eastern NSW — from the Richmond Ra. region, at Culmaron Ck, Richmond Ra. NP and at Iron Pot Ck, Toonumbar NP.

REMARKS. Small specimens (i.e. less than 2.5mm body length) have only a slight concentration of dense pigment in the eye region despite the presence of diffuse dorsal body pigment, and thus appear pale, almost white, to the naked eye (Fig. 36A). The cirrus is similar to that of *Temnosewellia keras* sp. nov. though larger and the introvert opening is oblique, not transverse.

Temnosewellia cypellum sp. nov.
(Figs 37A–B, 38)

ETYMOLOGY. From *kypellum* = goblet (Greek); a reference to the large goblet-shaped introvert.

MATERIAL. HOLOTYPE: QMG220942 (WM), from *Euastacus spinifer* [QMW26654], Mammy Johnsons Ck, at road bridge near Nature Reserve just SE of Stroud Road township, NSW (32°21.1'S 151°56.1'E), 21.11.1996, K.B. Sewell & R.D. Adlard., 100% alc/Bouin/Un. PARATYPES: QMG220943–220946 (WM), 100% alc/Bouin/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220947–220950 (MP), Euparol; QMG220951–220954 (CP), 100% alc/Fau; QMG220955–220959 (CP), Fau.

From *Euastacus spinifer*: NSW: [QMW20765], QMG220960–220961 (WM), Karuah R. at Washpool Bridge (32°21'S 151°55'S), 28.08.1995, J. Powell & R. Powell, hot Form/Un; QMG220962–220963 (WM), hot Bouin/Un; QMG220964–220965 (CP), hot Bouin/Fau; QMG220966–220967 (CP), hot Form/Fau; QMG220968 (CP), Fau. [AMP 33959], AMW28696 (WM), Cascade Ck at Girrakool, Brisbane Water NP (33°48'S 150°36'E), 9.10.1981, G.I. Morgan & S.J. Harders, unknown fixative/11x; AMW28697 (CP), unknown fixative/Fau; AMW28698–28699 (LS[14,6]), unknown fixative/H&E; [AMP 33958], AMW28700 (LS[4]), (Euroka Ck, nr Euroka Clearing, Blue Mts NP, (33°48'S 150°36'E), 15.10.1981, G.I. Morgan, unknown fixative/H&E

DESCRIPTION. Characteristics of genus; pattern of body pigment slightly punctate. Selected body measurements of type specimens from *Euastacus spinifer* are: QMG220942 (H): B(6234 × 3203), LE(4937), PH(887 × 1204, SD(1530), PD(796); QMG220943 (P): B(2958 × 1550), LE(829), PH(407 × 618, SD(772), PD(415); QMG220944 (P): B(5263 × 2591), LE(3815), PH(816 × 1020, SD(1346, PD(612); QMG220945 (P): B(6222 × 2856), LE(4284), PH(755 × 1102, SD(1428, PD(653); QMG220946 (P): B(5610 × 2795), LE(4019), PH(755 × 1061, SD(1367, PD(694).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert goblet-shaped; distal opening slightly oblique. Swelling near even, extends proximally well past introvert base on both sides, further on shorter side. Selected cirrus measurements of specimens from *Euastacus spinifer* from type locality are: QMG220952: S(835 × 202), I(242 × 65), IS(149 × 347); QMG220953: S(847 × 223), I(246 × 79), IS(198 × 262); QMG220955: S(851 × 266), I(242 × 85), IS(290 × 456); QMG220956: S(968 × 282), I(238 × 81), IS(319 × 387).

Epidermal Mosaic. see generic diagnosis.

HOST. *Euastacus spinifer.*

LOCALITIES. Mid-eastern NSW — from the Karuah R. near Stroud Road; from Brisbane Waters NP at Cascade Ck, Girrakool; and from the Blue Mountains NP at Euroka Ck, near the Euroka Clearing.

REMARKS. The pigment of this species is dense and slightly punctate, even in young worms. The cirrus is unusual as in Faure's preparations it consistently shows it has the longer side of the introvert on the shorter side of the shaft (i.e. the shaft curves in the opposite direction to that observed generally). The insertion region of the introvert eversion musele on the distal region of the introvert longer side is obviously bulbous and weakly selerotised.

Otherwise, the cirrus is most similar in shape and size to that of *Temnosewellia batiolis* sp. nov. but the introvert distal opening is slighly more oblique in *T. batiolis* sp. nov. as a consequence of a relatively shorter introvert shorter side. The cirrus of *Temnosewellia cypellum* sp. nov. is also similar to the cirrus of *T. fasciata*, a worm whose distribution is geographically close. The cirrus of the present species is, however, larger overall, has a relatively longer introvert shorter side, and lacks a collar of tissue just proximal to the base of the introvert.

The epidermal mosaic of *Temnosewellia cypellum* sp. nov. is identical to that described and photographed from worms identified tentatively as *Temnocephala* sp. 3. by Joffe & Cannon (1998: fig. 3D). Now able to be confirmed as *Temnosewellia minima* sp. nov., the latter worms were obtained from *Euastacus sulcatus* collected on 1.09.1994, by Sewell. K.B. at Spicers Gap, Main Ra. NP, Qld (28°04.0'S 152°26,3'E) and ident. by John Short, QM.

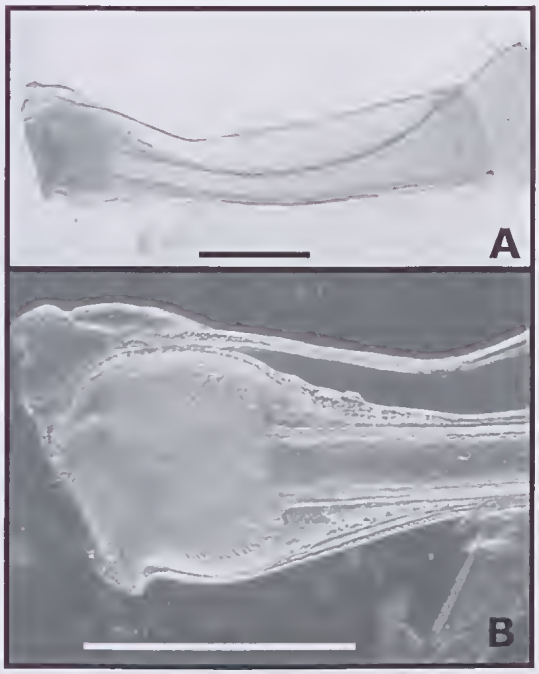


FIG. 37. *Temnosewellia cypellum* sp. nov. from *Euastacus spinifer.* A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220953, whole cirrus, scale = 250μm; B, QMG220953, introvert distal region, scale = 250μm.

Temnosewellia fasciata (Haswell, 1888) (Fig. 39A–C)

Temnocephala fasciata Haswell, 1888: 284: pl. 20 figs 1, 2, pl. 21, figs 1–7, 9–13, pl. 22, figs 1–7, 11–18.

Temnosewellia fasciata: Damborenea & Cannon, 2001: 1116.

ETYMOLOGY. Haswell (1888) provided no derivation of the name. Clearly it is from *fascia* = band, zone, stripe (Latin). Haswell (1888) stated that the body of this species has 'several, usually three, broad, transverse dark bands, separated from one another by lighter intervals'.

MATERIAL. From *Euastacus australasiensis* (juvenile). NSW: [QMW26586], QMG220900 (CP), Govetts Leap Brook, James St crossing on Braeside Walk, Blackheath, Blue Mts NP, (33°38.5'S 150°18.4'E), 12.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Fau.

From *Euastacus clarkae.* NSW: [QMW26598], QMG220926–220927 (WM), Cockerawombeeba Ck at Rimau Rd crossing, Werrikimbe NP (31°11.4'S 152°22.2'E), 23.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/MB/Hx; QMG220928–220929 (WM), HW/Form/Hx; QMG220930 (WM), HW/Form/Un; QMG220931–220934 (WM), HW/Form/Hx; [QMW26597], QMG220935 (CP), 7.02.2002,

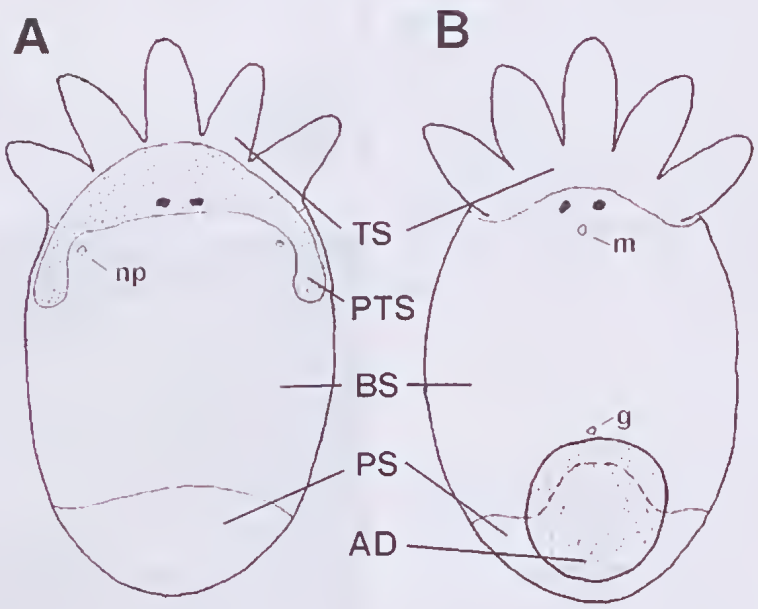


FIG 38. A. Mosaic of epidermal syncytia for *Temnosewellia cypellum* sp. nov. from *Euastacus spinifer* [QMW26654] from the Karuah R., NSW in (A) dorsal view, (B) ventral view. AD, adhesive disc syncytium; BS, body syncytium; PS, peduncular syncytium; PTS, post-tentacular syncytium; TS, tentacular syncytium; g, gonopore; m, mouth; np, nephridiopore; derived from 4 specimens: QMG220947–220950

K.B. Sewell & R.D. Sewell, 100% alc/Fau, [QMW26598], 23.10.1991, L.R.G. Cannon & K.B. Sewell, QMG220936–220939 (CP), HW/Form/Fau; QMG220940–220941 (LS[8,7]), Form/H&E.

From *Euastacus polysetosus*.NSW:[QMW26640], QMG220907–220908 (WM), Dilgry R., at Dilgry River Picnic Area, Barrington Tops NP, (31°53.6'S 151°31.3'E), 9.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; QMG220909–220911 (CP), 100% alc/Fau.

From *Euastacus* sp. NSW: [QMW26581], QMG220883–220888 (WM), Cudgegong R. at junction with Mill Ck. Wollemi NP, (32°50.7'S 150°14.4'E), 11.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; QMG220889 (CP), 100% alc/Fau; QMG220890–220898 (CP), Fau.

From *Euastacus spinifer*. NSW: [QMW26585], QMG220869–220871 (WM), Jamieson Ck, 0.5 km above Wentworth Falls, beside Darwins Walk, Blue Mts NP, (33°43.6'S 150°22.5'E), 12.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; QMW26584], QMG220872–220873 (WM), 20.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; [QMW26585], QMG220874–220876 (WM), 12.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Un; QMG219983 (CP), 100% alc/Fau; QMG220877–220882 (CP), Fau; [QMW26642], QM 220912 (WM), Problem Ck crossing on Frying Pan Rd, trib. of Telegherry R., Chichester SF, 1km E of Telegherry FP, (32°13.6'S 151°45.8'E), 10.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; QM 220913–220914 (WM), 70% alc/Un; QM 220915–220917 (WM), Bouin/Un; QM 220918–220919 (CP), 100% alc/Fau; QM 220920–220925 (CP), Fau; [QMW27490], QMG221216, (CP), 9.01.2004, D. Blair & R.D. Sewell, alc/Fau; [QMW27496], QMG221215 (CP), Govetts Leap Brook, James St crossing on Braeside Walk, Blackheath, Blue Mts NP, 2.01.2004 (34°37.1'S 150°32.5'E), Blair D. & Sewell R.D., alc/ Fau; [QMW27486], QMG221217 (CP), Piles Ck trib., beside the Great North Walk, Brisbane Waters NP (33°26.2'E 151°16.4'E), 8.01.2004, D. Blair & R.D. Sewell, alc/Fau.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical, as described and figured by Haswell (1893: plate X, fig. 1). Selected body measurements of specimens from *Euastacus spinifer* are: QMG220869: B(4325 × 3529), LE(3162), PH(714 × 1326, SD(1387, PD(571); QMG220870: B(4447 × 3346), LE(3223), PH(694 × 1163), SD(na), PD(632); QMG220871: B(3876 × 2672), LE(2713), PH(504 × 984), SD(1244, PD(490); QMG220872: B(2958 × 1612), LE(1958), PH(347 × 551), SD(632), PD(306); QMG220873: B(3060 × 1632), LE(2081), PH(408 × 551), SD(775), PD(326).

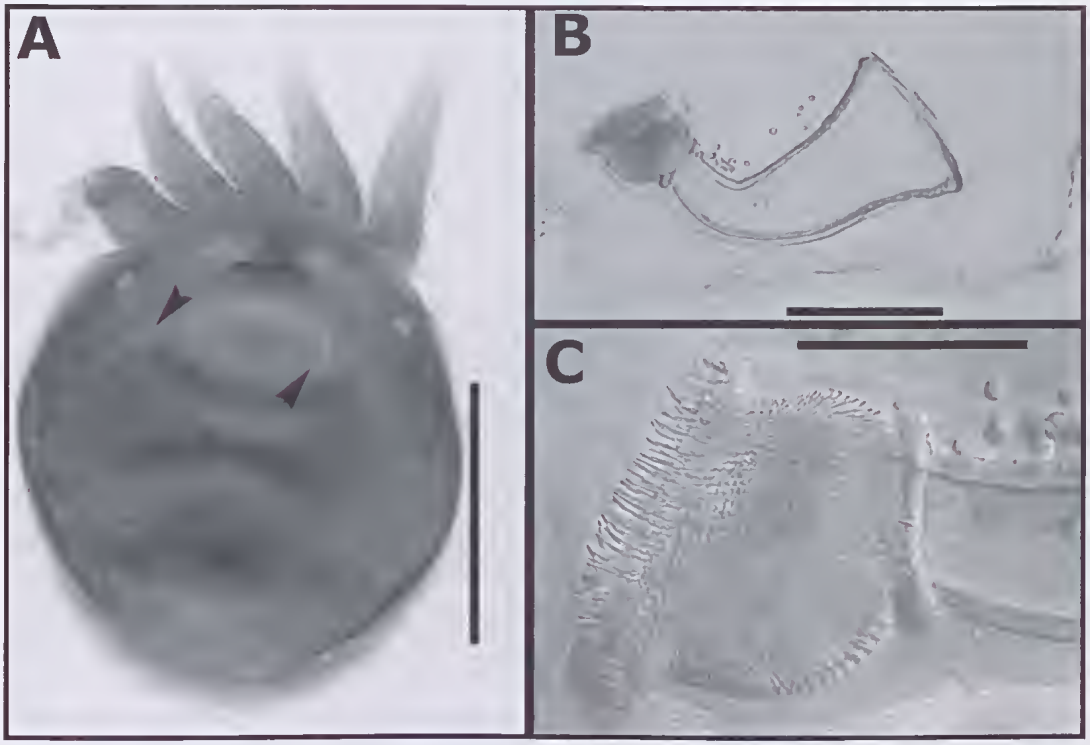


FIG. 39. *Temnosewellia fasciata* from *Euastacus australasiensis*. A, QMG220874, whole worm showing pigment pattern and non-pigmented outlines of facets (arrowheads), scale = 1mm; B–C. Nomarski interference contrast photomicrographs of Faure's preparations; B, QMG220878, whole cirrus, scale = 250μm; C, QMG220878, introvert distal region, scale = 250μm.

Reproductive System. Male. Cirrus: General form as figured by Haswell (1888: plate XXII, fig. 5; 1893: plate XIII, fig. 14). Shaft cone-shaped. Introvert essentially as figured by Haswell (1888: plate XXII, fig. 5; 1893: plate XIII, fig. 14) goblet-shaped; distal opening slightly oblique. Swelling uneven, extends proximally far past introvert base on both sides, much further on longer side. Selected cirrus measurements of specimens from *Euastacus spinifer* are: QMG220877: S(581 × 202), I(173 × 52), IS(113 × 359); QMG220878: S(532 × 262), I(161 × 60), IS(121 × 367); QMG220879: S(532 × 218), I(173 × 56), IS(141 × 323); QMG220880: S(484 × 181), I(173 × 60), IS(109 × 363); QMG220881: S(556 × 218), I(165 × 56), IS(137 × 290).

HOSTS. *Euastacus australasiensis, E. clarkae, E. polysetosus, E.* sp. nov?, *E. spinifer*.

DISTRIBUTION. Mid-eastern NSW — from the Wollemi NP; Weerikimbe NP; and the Blue Mountains NP.

REMARKS. There are no types of *Temnosewellia fasciata* lodged in any Australian museum. Nonetheless, we can confidently place these worms as *Temnosewellia fasciata* as they conform closely to the species description provided by Haswell (1888) and updated by Haswell (1893, 1924). In particular, the general form of the cirrus is close to that illustrated (without a scale bar) by Haswell (1888: plate XXII, fig. 5), and the relative dimensions of the swelling on the shorter side of the introvert conform closely to our specimens. We observed on our specimens a small aggregation of tissue that often encircles the shaft, just proximal to the introvert base, and thus resembles a collar.

We believe it likely that Haswell obtained the original specimens used to describe the species from the Blue Mountains region. Unfortunately, Haswell (1888) provided no clues as to the precise locality of these specimens, listing the host, *Astacopis serratus* as occurring in 'streams of New South Wales'. Haswell (1893) stated that he obtained *Temnosewellia fasciata* from *Astacopsis serratus* from 'various parts of the Blue Mountains, as well as from streams in the coastal districts,

FIG. 40. *Temnosewellia fax* sp. nov. from *Euastacus* c.f. *crassus*. A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220979, whole cirrus, scale = 250µm; B, QMG220979, introvert distal region, scale = 50µm.

from the Richmond River in the north, to the Yarra in the South'. The now known distribution of different *Euastacus* species across this range, coupled with the statement by Haswell (1893) that 'the specimens of *Astacopsis serratus* from different localities differ a good deal as regards colouration and other minor points' is evidence that he sampled a considerable number of different host species.

Haswell (1888) stated that the body of this species has 'several, usually three, broad, transverse dark bands, separated from one another by lighter intervals'. We believe that he, (Haswell, 1888) was referring to the pattern of open spaces in the parenchymal pigment ventral to the dorsal network created by the unpigmented neural plexus. We have seen video footage of a large colony of *Temnosewellia fasciata* living on *Euastacus spinifer* in the laboratory and can confirm that a significant proportion of the population of worms appear to have dorsal transverse dark and light (white) bands of somewhat variable thickness and pattern. Later, Haswell (1893) suggested that the pattern of the 'darker and lighter zones' of pigment found in *Temnosewellia fasciata* did not always conform exactly to the pattern described in Haswell (1888).

The pigment pattern observed here for *Temnosewellia fasciata* conforms essentially to that described for the species by Haswell (1893), and indeed is typical of most *Temnosewellia* species with body pigment and occurring on *Euastacus* crayfish (see, for example, Fig. 28A). Haswell (1893) described accurately the body pigment of *Temnosewellia fasciata* as comprised of a fine, close network of very delicate threads of granular pigment which are darker on the dorsal surface. Haswell (1893: plate X, fig. 1) described and figured a principal layer of pigment dorsally just below the basement membrane and less dense pigment ventral to this layer throughout the parenchyma. The cirrus of the present species most closely resembles that of *Temnosewellia batiola* sp. nov., but the introvert opening is not as wide.

Some specimens (AMW28703–28711) identified as *Temnocephala* [= *Temnosewellia*] *fasciata* by W. A. Haswell in the collection of the Australian Museum, Sydney were from *Astacopsis serratus* [= *Euastacus* spp.] collected at Leura, Blue Mountains, NSW. These specimens we consider to represent the variety of *Temnosewellia fasciata* described briefly and figured (Haswell (1893: plate XIII, fig 14), and which we have named *Temnosewellia possibilitas* sp. nov. in the present study.

Temnosewellia fax sp. nov.
(Fig. 40A–B)

ETYMOLOGY. From *fax* = torch, flame (Latin); a reference to the shape of the cirrus introvert.

MATERIAL. HOLOTYPE: From *Euastacus armatus* [QMW26582], QMG220969 (WM), Buffalo R., Shultz Track, 36km S of Buffalo, VIC (36°59.5'S 146°48.0'E), 10.03.2002, G.N. Edney, 100% Alc/Un. PARATYPES: QMG220970–220973 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220974–220981 (CP), 100% alc/Fau; from *Euastacus* cf. *crassus* [QMW26596], QMG220899 (CP), 10.03.2002, G.N. Edney, 100% Alc/Un. OTHER MATERIAL. From *Euastacus hirsutus*. NSW: [unreg. host], QMG220181 (WM), Belmore Falls, in stream above falls (34°38.5'S 150°33.3'E), 9.03.1939, unknown fixative/Hx.

From *Euastacus yanga*. NSW: [QMW26626], QMG221008 (WM), Burrawang Ck at road crossing, 3km NW Belmore Falls, Morton NP, NSW (34°37.1'S 150°32.5'E), 13.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Un; QMG221009 (CP), 70% alc/Fau.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus armatus* are: QMG220969 (H): B(3448 × 2326), LE(2224), PH(530

× 632), SD(854), PD(366); QMG220970 (P): B(4508 × 3244), LE(2897), PH(694 × 1000), SD(1000), PD(592); QMG220971 (P): B(3917 × 3713), LE(2958), PH(775 × 1020), SD(1326), PD(612); QMG220972 (P): B(3937 × 3366), LE(2897), PH(734 × 979), SD(1224), PD(632); QMG220973 (P): B(4824 × 2978), LE(2754), PH(755 × 867), SD(898), PD(510).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert cylinder to scoop-shaped; distal opening oblique. Swelling slightly uneven(?), extends proximally somewhat past introvert base on longer side, less on shorter side. Selected cirrus measurements of specimens from *Euastacus armatus* from type locality are: QMG220976: S(354 × 124), I(77 × 20), IS(19 × na); QMG220977: S(380 × 100), I(75 × 20), IS(26 × 19(?)); QMG220978: S(358 × 136), I(71 × 20), IS(27 × na); QMG220979: S(366 × 122), I(65 × 20), IS(22 × 17(?)); QMG220980: S(373 × 132), I(75 × 20), IS(23 × na).

HOSTS. *Euastacus armatus*, *E.* cf. *crassus*; *E. hirsutus*, *E. yanga*.

DISTRIBUTION. Mid-eastern NSW — from the Belmore Falls region, W of Kaima. Southern VIC — from the southern Gippsland region, near Buffalo.

REMARKS. The cirrus of this species was invariably strongly curved in the specimens examined here and may be a useful character. However, we prefer not to put too much emphasis on cirrus curvature in distinguishing between species. The introvert in most cases appears collapsed and folded which leads to the flame-like appearance. The cirrus is somewhat similar to that of *Temnosewellia comythus* sp. nov., though smaller overall with an introvert smaller relative to shaft length.

We include tentatively here specimens from *Euastacus yanga* collected from Burrawang Ck, a tributary of Barrengarry Ck, and upstream of Belmore Falls, NSW despite the large geographical distance between this location and those in VIC.

Temnosewellia flammula sp. nov.
(Fig. 41A–B)

ETYMOLOGY. From *flamma* = fire (Latin, diminutive); a reference to the tiny flame-like introvert on the fluted end of the cirrus shaft.

MATERIAL. HOLOTYPE: QMG220860 (WM), from *Euastacus neohirsutus* [QMW26650], Middle Ck trib., beside road 6 km upstream from Corritts Water, NSW (30°21.4'S 152°29.1'E), 6.02.2002, K.B. Sewell & R.D. Sewell, 70% ale/Un. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26651], QMG220862 (WM) [juvenile], 15.02.1992, K.B. Sewell & S.G. Sewell, HW/Form/Hx; [QMW26650], QMG220864 (CP), 6.Feb.2002, K.B. Sewell & R.D. Sewell, 100% alc/Fau.

FIG. 41. *Temnosewellia flammula* sp. nov. from *Euastacus neohirsutus*. A–C. Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220864. Whole cirrus. Scale = 100µm. B, QMG220864. Introvert distal region. Scale = 50µm.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of holotype from *Euastacus neohirsutus* are: QMG220860 (H): B(1764 × 1171), LE(1244), PH(346 × 520, SD(537), PD(272).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert tiny, scoop-shaped; distal opening oblique. Swelling not observed. Selected cirrus measurements of specimens from *Euastacus neohirsutus* are: QMG220860 (H) [WM]: S(242 × 48), I(17(?) × 12), IS(na × na); QMG220864: S(148 × 26), I(18(?) × 12), IS(121 × 367).

HOST. *Euastacus neohirsutus*.

DISTRIBUTION. North-eastern NSW — from Middle Ck, W of Dorrigo.

REMARKS. The tiny cirrus and introvert discriminates this species despite only a few specimens being available. It is similar to that of *Temnosewellia minima* sp. nov., but the introvert is relatively smaller and more flame-like. Measurements of the length of the cirrus introvert are tentative and must be confirmed from additional specimens. Body pigment was well developed in the single, small juvenile specimen examined.

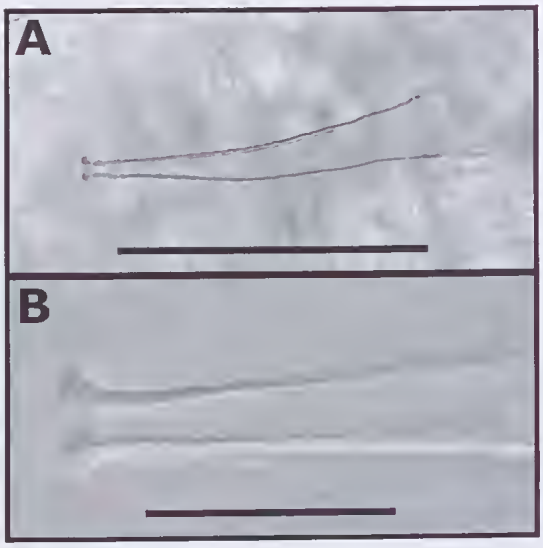


FIG. 42. *Temnosewellia gingrina* sp. nov. from *Euastacus suttoni*. A, B. Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220739. Whole cirrus. Scale = 250µm. B, QMG220739. Introvert distal region. Scale = 50µm.

Temnosewellia gingrina sp
(Fig. 42A–B)

ETYMOLOGY. From *gingrina* = small flute (Latin, feminine); a reference to the small, narrow cirrus with a fluted end.

MATERIAL. HOLOTYPE: QMG220729 (WM), from *Euastacus suttoni* [QMW26663], Washpool Ck, nr Thunderbolts Hideout, N of Tenterfield (28°58.4'S 152°04.4'E), 4.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un.PARATYPES: QMG220730–220733 (WM), hot Bouin/Un. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26661], QMG220734–220738 (CP), 19.12.2001, K.B., S.G., R.D. & M.R. Sewell, 100% alc/Fau; QMG220739–220744 (CP), Fau. OTHER MATERIAL. From *Euastacus dangadi*. NSW: [QMW26604], QMG220745–220747 (WM), Eungai Ck trib., at Cedar Crossing, Ngaamba NR., Ingalba SF (30°53.9'S 152°47.3'E), 24.03.2002, K.B. Sewell, 100% alc/Un; [QMW26605], QMG220748 (CP), 6.02.2002, K.B. Sewell & R.D. Sewell, 100% alc/Fau; [QMW26604], QMG220749–220750 (CP), 24.03.2002, K.B. Sewell, 100% alc/Fau.

From *Euastacus gumar*. NSW: [QMW26622], QMG220751 (WM), Culmaron Ck, Richmond Ra. NP (28°50.5'S 152°44.1'E), 4.03.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, 100% alc/Bouin/Un; QMG220752 (WM), 100% alc/Un; QMG220753–220754 (CP), 100% alc/Fau; QMG220755 (CP), Fau.

From *Euastacus sulcatus*. NSW: [QMW26655], QMG220543 (WM), Bundoozle Flora Reserve, Richmond Ra. NP, NSW (28°36.4'S 152°42.1'E), 4.03.2002, K.B. Sewell, S.G. Sewell & J.A. Coughran, 100% alc/Bouin/Un; QMG220544 (WM), 100% alc/Un; QMG220545 (WM), 100% alc/Bouin/Un; QMG220546–220547 (CP), 100% alc/Fau.; QMG220548–220551 (CP), Fau; QMG220552–220553 (CP), 100% alc/Bouin/Fau.

From *Euastacus suttoni*. Qld: [QMW26660], QMG220756 (WM) beside rd to The Pyramids, Girraween NP (28°49.1S 151°58.8'E), 18.04.1990, S. Cook, Carn/Hx; QMG220757 (WM), HW/Form-Acetic/Hx; QMG220758 (WM), Form-Acetic/MB/Hx; QMG220759 (WM), Form-Acetic/Hx; ; QMG220760 (WM), HW/Form-Acetic/Hx; QMG220761 (WM) Form-Acetic/Hx; QMG220762–220763 (WM) HW/Form-Acetic/Hx; QMG220764 (WM), Carn/MB/Hx; QMG220765 (WM) hot Form-Acetic/Hx; QMG220766–220770 (CP), HW/70% alc/Fau; QMG220771–220772 (LS[5,3]), Bouin/H&E; QMG220773–220775 (LS[1,4,12]), HW/Form-Acetic/H&E; QMG220776 (LS[12]), Bouin/H&E; QMG220777–220778 (LS[5,7]), Form-Acetic/H&E; QMG220779–220780 (LS[5,8]), Carn/H&E; QMG220781–220782 (LS[6,4]), Form-Acetic/H&E; QMG220783–220784 (LS[3,5]), Bouin/H&E; QMG220785 (LS[6]), Carn/H&E.

NSW: [QMW6463], QMG220786–220789 (WM), Poverty Point, 24.1km SE Tenterfield (29°08'S 152°20'E), Dec. 1973, A. Martin, 70% alc(?)/Hx; [QMW6465], QMG220790 (WM) Poverty Point, nr Tenterfield (29°08'S 152°20'E), J. Toop, 70% alc(?)/Hx; QMG220791–220793 (CP), Poverty Point, 24.1km SE Tenterfield (29°08'S 152°20'E), Dec. 1973, A. Martin, 70% alc(?)/Fau; QMG220794–220797 (LS[7,18,12,15]), 70% alc(?)/H&E; [QMW6468], QMG220798–220799 (WM), Gibralter Ra. NP (29°35'S 152°13'E), 19.12.1972, S.R. Monteith, 70% alc(?)/Hx; [QMW26662],QMG220800–220802 (WM), Glen Innes, Dec. 1976, I. Kneipp, 70% alc/Hx; QMG220803–220804 (CP), 70% alc/Fau; QMG220805–220806 (LS[3,2]), 70% alc/H&E.

From *Euastacus valentulus*. NSW: [QMW6459], QMG220807 (WM), Rocky Ck rainforest, Whian Whian SF (28°40'S 153°18'E), Jul. 1974, G.B. Monteith & S.R. Monteith., 70% alc/MB/Hx; QMG220808–220810 (WM), 70% alc/Hx; QMG220811–220812 (WM), 70% alc/Un; QMG220813–220814 (WM), 70% alc/MB/Hx; QMG220815–220820 (CP), 70% alc/Fau; QMG220821–220823 (LS[1,6,26]), 70% alc/H&E.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus suttoni* are: QMG220729 (H): B(5100 × 2570), LE(3448), PH(694 × 918), SD(1306), PD(510); QMG220730 (P): B(2490 × 2142), LE(3080), PH(592 × 836), SD(1081), PD(469); QMG220731 (P): B(2250 × 1285), LE(1714), PH(367 × 449), SD(612),

PD(306); QMG220732 (P): B(4753 × 2489, LE(3427), PH(673 × 775), SD(1244), PD(510); QMG220733 (P): B(7099 × 3203), LE(5161), PH(979 × 1285), SD(1469), PD(694).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert lacks spined region, but has some low cusp-like protuberences on distal rim of cirrus shaft; distal opening absent (corresponds with introvert base). Swelling absent(?). Selected cirrus measurements of specimens from *Euastacus suttoni* from type locality are: QMG220734 S(270 × 67), I(na × 17); QMG220735 S(335 × 91), I(na × 18); QMG220737 S(360 × 112), I(na × 19); QMG220739 S(319 × 67), I(na × 18); QMG220740 S(348 × 65), I(na × 18).

HOSTS. *Euastacus dangadi, E. gumar, E. suttoni, E. sulcatus, E. valentulus.*

DISTRIBUTION. South-eastern Qld — from Girraween NP, near Eukey.

North-eastern NSW — from Richmond Ra. NP at Culmaron Ck and at Bundoozle FR; from the Tenterfield area at Washpool Ck and at Poverty Point; from Ngaamba NR, Ingalba SF at Cedar Crossing; and from Whian Whian SF at Rocky Ck rainforest.

REMARKS. The introvert lacks spines and appears reduced to no more than a fluted flange with low cusp-like protuberances. Neither an unspined distal region nor an introvert swelling was observed. Presumably the distal end of the shaft serves as the intromittent organ. The cirrus is most similar to that of *Temnosewellia aspinosa* sp. nov., but the proximal diameter is much greater in that species.

Temnosewellia gracilis sp. nov. (Fig. 43A–B)

ETYMOLOGY. From *gracilis* = slender (Latin); a reference to the appearance of the cirrus.

MATERIAL.HOLOTYPE. QMG220982 (WM), from *Euastacus guwinus*? (cf. *dharawalus*) [QMW26624] Tianjarra Ck, above Tianjarra Falls, Morton NP, NSW (35°06.7'S 150°19.8'E), 18.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx. PARATYPES: [QMW26623], QMG220983–220984 (WM), 18.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220985–220987 (WM), [QMW26623], 18.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; QMG220988–220989 (CP), 100% ale/Fau; QMG220990–220992 (CP), Fau; [QMW26624], QMG220993 (LS[6]), 18.10.1991, L.R.G. Cannon & K.B. Sewell, Form/H&E.

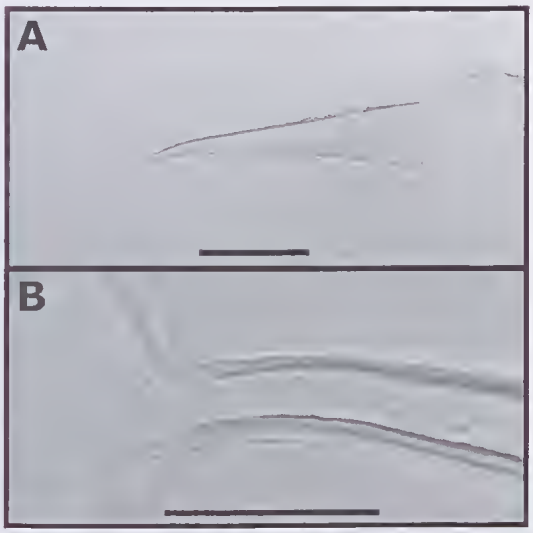


FIG. 43. *Temnosewellia gracilis* sp. nov. from *Euastacus guwinus* (cf. *dharawalus*). A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220991, whole cirrus, scale = 250µm; B, QMG220991, introvert distal region, scale = 50µm.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus guwinus*? (c.f. *dharawalus*) are: QMG220982 (H): B(3529 × 1979), LE(2366), PH(390 × 667), SD(846), PD(350); QMG220983 (P): B(5304 × 3019), LE(3774), PH(626 × 935), SD(1138), PD(447); QMG220984 (P): B(4039 × 2693), LE(2876), PH(455 × 813), SD(1016), PD(528).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert tiny, scoop-shaped; distal opening oblique. Swelling uneven, extends proximally slightly past introvert base on longer side, shorter side not observed. Selected cirrus measurements of specimens from *Euastacus guwinus*? (cf. *dharawalus*) from type locality are: QMG220990: S(620 × 136), I(22 × 18), IS(na × na); QMG220991: S(681 × 144), I(26 × 18), IS(na × na); QMG220992: S(671 × 173), I(26 × 14), IS(na × na).

HOST. *Euastacus guwinus*? (cf. *dharawalus*).

DISTRIBUTION. Mid-eastern NSW — from W of Nowra, Morton NP, at Tianjarra Falls.

REMARKS. The cirrus of this species is large, but the introvert is extremely small and fine details are difficult to resolve. It perhaps resembles that of *Temnosewellia acicularis* sp. nov., but has a relatively wider proximal diameter and the

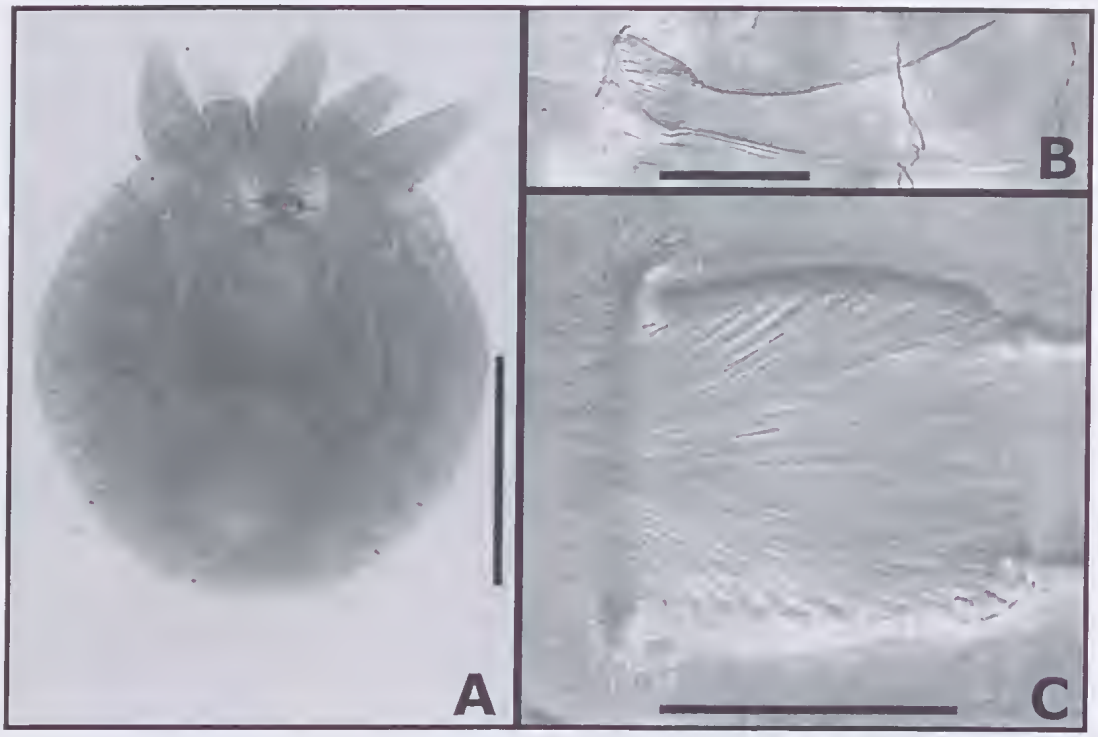


FIG. 44. *Temnosewellia keras* sp. nov. from *Euastacus yarraensis*. A, QMG221117, whole worm (Holotype) showing pigment pattern, scale = 1mm; B–C, Nomarski interference contrast photomicrographs of Faure's preparations; B, QMG221124, whole cirrus, scale = 100µm; C, QMG221130, introvert distal region, scale = 50µm.

introvert is much smaller. The introvert swelling on the longer side of the introvert is clearly wider than that on the shorter side, but its extent otherwise could not be determined. Very fine spines are present.

Temnosewellia keras sp.nov.
(Fig. 44A–C)

ETYMOLOGY. From *keras* = horn (Greek, noun); a reference to the shape of the cirrus.

MATERIAL. HOLOTYPE: QMG221117 (WM), from *Euastacus yarraensis* [QMW26593], SF nr Cockatoo beside road in picnic area (37°56.6'S 145°29.6'E), 21.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un. PARATYPES: QMG221118–221121 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG221122–221126 (CP), 100% alc/Fau. OTHER MATERIAL. From *Euastacus kershawi*. VIC: [QMW26630], QMG221134 (CP), Labertouche Ck (Tarago R. trib.), on Old Telegraph Rd, W of Jindivick, VIC (38°03.2'S 145°50.1'E), 21.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un.

From *Euastacus yarraensis*. VIC: [QMW26673], QMG221127 (WM), Labertouche Ck (Tarago R. trib.), on Old Telegraph Rd, W of Jindivick, VIC (38°03.2'S 145°50.1'E), 8.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx; QMG221128 (WM), HW/Form/Un; QMG221129–221130 (CP), HW/Form/Fau; QMG221131–221133 (LS [7,3,7]), HW/Form/H&E; [unreg. host, ident. Dr Susan Lawler, Latrobe University, VIC], QMG221213 (CP), Otways Love Ck, at picnic ground, Kawarren, Otways (38°28.8'E 143°35.0'E), 1.01.2004, D. Blair, R.D. Sewell, S.H. Lawler & G.N. Edney, alc/Fau. [NMVJ 6156] NMVF 93852–93856 (WM), Bunyip River, top of road from Princes Highlwy (37°55'S 145°43'E) 18.02.1977, P.S. Lake, 70% alc(?)/Hx; NMVF 93857–93858 (WM), 70% alc(?)/Un, NMVF 93859–93860 (CP), 70%alc(?)/Fau: NMVF 93863 (LS[7]), 70% alc(?)/H&E.

From *Astacopsis serratus* [= *Euastacus* spp]. VIC: [unreg. host]. NMVF 93864–93866 (WM), Headwaters of Lederberger R., Blackwood (37°35'S 144°24'E), 15.10.1956, unknown fixation/carmine(?); NMVF 93867–93869 (CP), unknown fixation/Fau; NMVF 93897–93901 (WM), unknown fixation/Hx(?);NMVF 93902 (LS[8]), unknown fixation/H&E.

From *Hyridella (Hyridella) depressa* (Lamarck, 1819)) (Mollusca; Bivalvia; Unionoidea: Hyriidae)

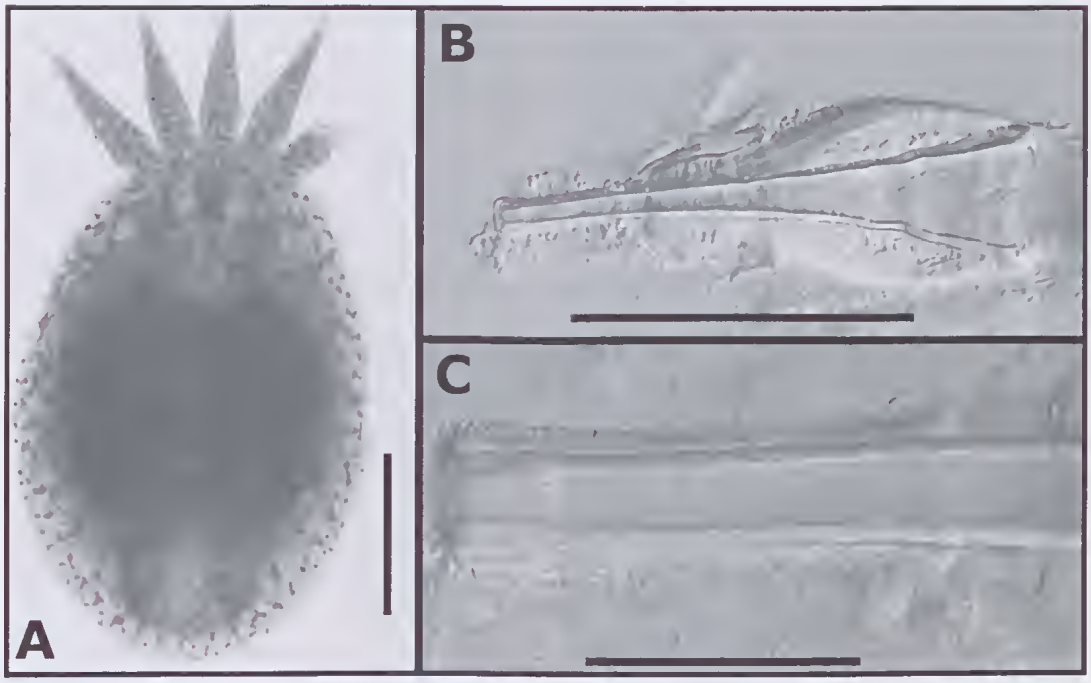


FIG. 45. *Temnosewellia maculata* sp. nov. from *Euastacus bispinosus*. A, QMG221150, whole worm (Holotype) showing punctate pigment pattern, scale = 1mm; B–C, Nomarski interference contrast photomierographs of Faure's preparations; B, QMG221155, whole cirrus, scale = 250µm; C, QMG221155, everted introvert distal region, scale = 50µm.

[probably a spurious record; see Remarks]. VIC: [unreg. host], NMVF 93870–93871 (WM), Forrest (38°31'S 143°43'E), 1948, A. Wilhelms, unknown fixation/carmine(?); NMVF 93872–938714 (CP), unknown fixation/Fau; NMVF 93876–93884 (LS[3,4,3,3,1,1,1,1,1), unknown fixation/H&E(?).

DESCRIPTION. Characteristics of genus; pattern of body pigment typical, sometimes punctate. Selected body measurements of type specimens from *Euastacus yarraensis* are: QMG221117 (H): B(2550 × 2020), LE(1693), PH(480 × 537), SD(821), PD(366); QMG221118 (P): B(3264 × 1918), LE(1979), PH(520 × 553,) SD(829), PD(358); QMG221119 (P): B(3060 × 1734), LE(2122), PH(447 × 528), SD(691), PD(386); QMG221120 (P): B(2713 X1693), LE(1918), PH(431 × 626), SD(854), PD(358); QMG221121 (P): B(3182 × 1897), LE(2122), PH(488 × 650), SD(870), PD(423).

ReproductiveSystem. Male. Cirrus: Shaft cone-shaped. Introvert cylinder to cone-shaped; distal opening not oblique. Swelling near even, tapers rapidly just distal to introvert base and [apparently] does not extend proximally past introvert base. Selected cirrus measurements of specimens from *Euastacus yarraensis* from type locality are: QMG221123: S(167 × 71), I(63 × 41), IS(na × na); QMG221124: S(226 × 106), I(63 × 37), IS(na × na); QMG221125: S(217 × 102), I(63 × 42), IS(na × na); QMG221126: S(183 × 81), I(63 × 44), IS(na × na).

HOSTS. *Astacopsis serratus* [= *Euastacus* spp.], *Euastacus kershawi*, *E. yarraensis*.

DISTRIBUTION. From the region of Melbourne, VIC.

REMARKS. This is one of several species with a simple cone-shaped introvert with a transverse distal opening. It most closely resembles *Temnosewellia coughrani* sp. nov., but is smaller and the latter has an oblique opening to the introvert and the introvert swelling is not apparent, whereas in *T. keras* sp. nov., it is even. The record from the freshwater, unionid bivalve, *Hyridella (Hyridella) depressa,* is probably spurious and has very likely resulted from placement of this mollusc and a crayfish together in the same container when collected in the field.

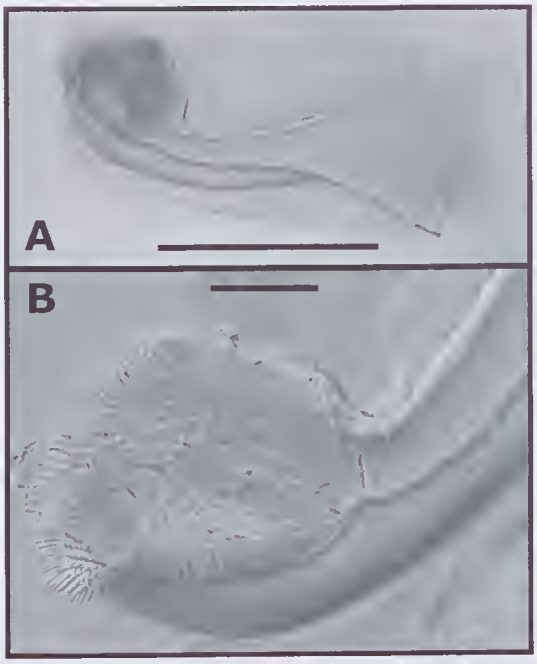


FIG. 46. *Temnosewellia magna* sp. nov. from 'Lobster' [= *Euastacus armatus*?]. A, B. Nomarski interference contrast photomicrographs of Faure's preparations. A, NMVF93818, whole cirrus, scale = 500µm; B, NMVF93818, introvert distal region, scale = 100µm.

Temnosewellia maculata sp. nov.
(Fig. 45A–C)

ETYMOLOGY. From *maculosus* = dappled or spotted (Latin); a reference to the dappled or spotted body pigment.

MATERIAL. HOLOTYPE: QMG221150 (WM), from *Euastacus bispinosus* [QMW26591], Jimmys Ck, at picnic ground 6.5km WNW Mafeking, VIC (37°23'S 142°34'E), 5.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx. PARATYPES: QMG221151 (WM), HW/Form/Hx; QMG221152–221153 (WM), HW/Form/MB/Hx; QMG221154 (WM), HW/Form/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG221155 (CP), Form/Fau; QMG221156–221159 (CP), HW/Form/Fau; QMG221160–221161 (LS[7,7]), Form/H&E. OTHER MATERIAL. From *Euastacus bispinosus*. VIC; [unreg. host], QMG221218 (CP), Rose Ck, just downstream of Burrang Falls, Grampians NP, (37°09.0'E 142°22.7'E), 31.12.2003, D. Blair, R.D. Sewell, S.H. Lawler & G.N. Edney, alc/Fau. SA: [AMP 25029], AMW28701–28702 (WM), Mt Gambier, Ewens Ponds (37°50'S, 140°47'E), 6.09.1975, N. Coleman, unknown fixative/Hx.

DESCRIPTION. Characteristics of genus; pattern of body pigment punctate. Selected body measurements of type specimens from *Euastacus bispinosus* are: QMG221150 (H): B(4141 × 2285), LE(2795), PH(447 × 618), SD(976), PD(398); QMG221151 (P): B(4855 × 2448), LE(3295), PH(593 × 691), SD(1041), PD(488); QMG221152 (P): B(3142 × 1673), LE(2020), PH(366 × 528), SD(724), PD(301); QMG221153 (P): B(1754 × 480), LE(1510), PH(207 × 407), SD(236), PD(504); QMG221154 (P): B(4488 × 2550), LE(3060), PH(569 × 789), SD(829), PD(455).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert cylinder shaped; distal opening slightly oblique. Swelling near equal(?), extending proximally slightly past introvert base on both sides, about equal on both sides. Selected cirrus measurements of specimens from *Euastacus bispinosus* from type locality are: QMG221155: S(295 × 93), I(98 × 18), IS(na × na); QMG221156: S(354 × 79), I(96 × 16), IS(na × na); QMG221157: S(370 × 65), I(96 × 15), IS(na × na).

HOST. *Euastacus bispinosus*.

DISTRIBUTION. South western VIC from The Grampians NP, at Jimmys Ck, near Mafeking. South eastern SA — from the Mt Gambier region, at Ewens ponds.

REMARKS. This is the most strongly pigmented species examined here. The pigment is punctate, even in small specimens (Fig. 45A). Moreover, in larger specimens of this species, punctate pigment occurs in the dorsal region of the sucker disc and occasionally in the ventral region. The introvert is distinctive among the group with punctate pigment, being long and narrow and armed with relatively uniform small spines. *Temnosewellia minima* sp. nov. also has a cylindrical introvert, but the whole cirrus is half the size and the introvert much smaller than in the present species.

Temnosewellia magna sp. nov.
(Fig. 46A–B)

ETYMOLOGY. From *magnus* = large (Latin); a reference to the large size of the goblet shaped introvert.

MATERIAL. HOLOTYPE. NMVF 93811 (WM), from 'Lobster' [= *Euastacus armatus*?], [unreg. host], Wangaratta, King River (36°21'S 146°19'E), 10.09.1918, C.F. Cole, unknown fixation/carmine(?). PARATYPES. NMVF 93812 (WM), unknown fixation, carmine(?); NMVF 93813 (WM), unknown fixation/Hx. OTHER SPECIMENS FROM TYPE LOCALITY: NMVF 93814–93820 (CP), unknown fixation/Fau; NMVF 93821–93822 (LS[6, 5]), unknown fixation/

unknown stain [H&E(?)], NMVF 93823 (LS [8]), unknown fixation/Hx.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of specimens from 'Lobster' from type locality are: NMVF 93811 (H): B(8017 × 3346), LE(5365), PH(1061 × 1346, SD(1836), PD(877); NMVF 93812 (P): B(8792 × 3815), LE(571), PH(1081 × 1550, SD(1428), PD(775); NMVF 93813 (P): B(3570 × 2550), LE(2897), PH(714 × 898, SD(1285), PD(490).

Reproductive System. Male. Cirrus: Shaft cone to funnel-shaped. Introvert goblet-shaped; distal opening oblique. Swelling near even, extends proximally well past the introvert base, slightly farther on longer side. Selected cirrus measurements of specimens from 'Lobster' from type locality are: NMVF 93814: S(754 × 496), I(323 × 133), IS(399 × 306); NMVF 93815: S(782 × 556), I(331 × 149), IS(399 × 286); NMVF 93816: S(774 × 468), I(302 × 133), IS(472 × 294); NMVF 93818: S(655 × 403), I(302 × 85), IS(383 × 266).

HOST. *Euastacus armatus*?

DISTRIBUTION. King River at Wangaratta, Victoria

REMARKS. This worm reaches an extremely large size, with some specimens almost 9mm body length. Based on the approximate ranges of *Euastacus* species presented by Morgan (1986) the host is most likely to be *E. armatus*. The introvert swelling is particularly prominent on the longer side of the introvert. The very large size of the cirrus and its goblet shape make it most similar to *Temnosewellia maxima* sp. nov., *T. batiola* sp. nov. and *T. fasciata*, however, the introvert swelling is uneven in the last two species. *Temnosewellia magna* sp. nov. differs from *T. maxima* sp. nov.as the shaft flares more proximally in the former.

Temnosewellia maxima sp. nov.
(Fig. 47A–B)

ETYMOLOGY. From *maximus* = greatest (Latin); a reference to the great size of the cirrus.

MATERIAL. HOLOTYPE: QMG220608 (WM), from *Euastacus sulcatus* [unreg. host, ident. Ron Monroe, Curator of Crustacea, QM], Nagarigoon Falls, Lamington NP, Qld (28°13.3'S 153°12.0'E), 31.03.1976, R. Monroe, 70% alc(?)/Hx. PARATYPES: QMG220609 (WM), 70% alc(?)/Hx; QMG220610–220611 (WM), 70% alc(?)/Hx. OTHER MATERIAL FROM TYPE LOCALITY: QMG220612–220614

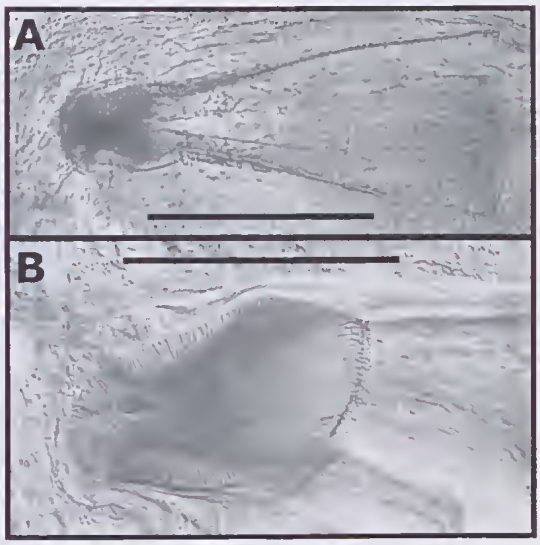


FIG. 47. *Temnosewellia maxima* sp. nov. from *Euastacus sulcatus*. A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220614, whole cirrus, scale = 500μm; B, QMG220612, introvert distal region, scale = 250μm.

(CP), 70% alc(?)/Fau; QMG220615–220617 (LS[14,13,8]), 70% alc(?)/H&E. OTHER MATERIAL. From *Euastacus sulcatus*. Qld: [unreg. host, ident. collector as 'Blue Land Crayfish'], QMG220618–220619 (WM), Lamington NP (28°19'S 153°05'E), 3.02.1984, W. Higgins, 70% alc/Hx; QMG220620–220621 (LS[14,17]), 70% alc/H&E; [unreg. host, ident. Dr John Short, QM], QMG220622 (WM), Mt Huntley, at spring beside walking track nr summit, Main Ra. NP (28°08.8'S 152°26.6'E), 30.01.1993, G.B. Monteith, HW/Bouin/Hx; QMG220623 (WM) HW/Bouin/MB/Hx; QMG220624–220627 (WM), 70% alc/Un; QMG220628–220629 (LS[25,25]) HW/Bouin/H&E.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus sulcatus* are: QMG220608 (H): B(6793 × 4080), LE(5406), PH(918 × 1632), SD(1734), PD(1020); QMG220609 (P): B(5977 × 4162), LE(4080), PH(1122 × 1428), SD(na), PD(857); QMG220610 (P): B(4141 × 2632), LE(3121), PH(673 × 836), SD(1020), PD(490); QMG220611 (P): B(6467 × 3876), LE(4570), PH(1020 × 1571), SD(1673), PD(714).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert scoop to goblet-shaped; distal opening oblique, often folded into irregular shape. Swelling even, extends proximally well past introvert base equally distance on each side.

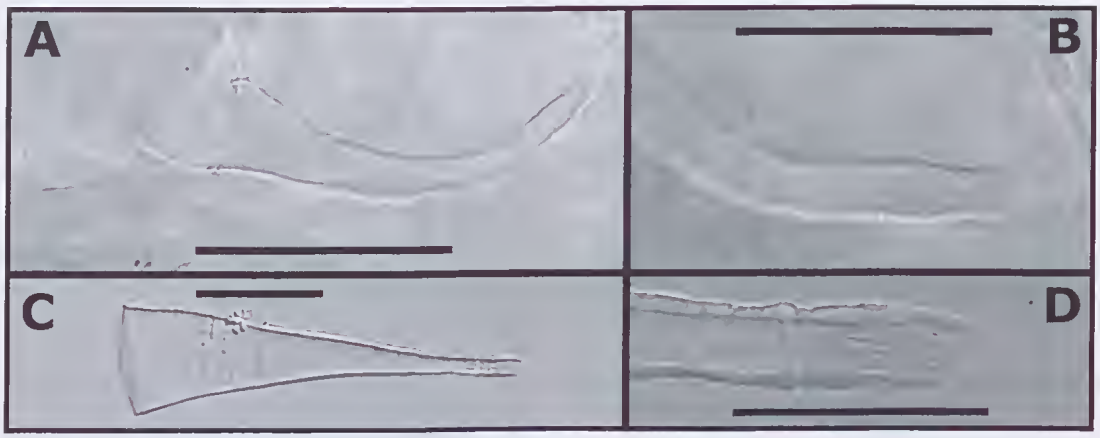


FIG. 48. *Temnosewellia minima* sp. nov. from *Euastacus sulcatus*. A–D, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG220585, whole cirrus, scale = 100μm; B, QMG220585, introvert distal region, scale = 50μm; C, QMG220594, whole cirrus, scale = 100μm; D, QMG220594, introvert distal region, scale = 50μm.

Selected cirrus measurements of specimens from *Euastacus sulcatus* from type locality are: QMG220612: S(314 × 323), I(258 × 121), IS(210 × na); QMG220613 [juvenile]: S(101 × 173), I(246 × 133), IS(101 × 101); QMG220614: S(746 × 411), I(242 × 137), IS(343 × 343).

HOST. *Euastacus sulcatus*.

DISTRIBUTION. South-eastern Qld — from the Lamington NP region, and at Mt Huntley.

REMARKS. This species was the largest examined in the present study, with one specimen from Lamington NP (QMG220618) being over 10mm in body length. The body pigment of these worms, while typical, is fine and thus appears shadowy. The cirrus is extremely large and may be distinguished from the most similar species *Temnosewellia magna* sp. nov. by the proximal diameter of the shaft, which is relatively much greater in the latter species.

Temnosewellia minima sp. nov.
(Fig. 48A–D)

Temnocephala sp. 3. Joffe & Cannon (1998: 3)

ETYMOLOGY. From *minimus* = least (Latin); a reference to the tiny size of the cirrus.

MATERIAL. HOLOTYPE: QMG220581 (WM), from *Euastacus sulcatus*, [QMW26657], upper Tallebudgera Ck, at '1000m mark on main track' (28°14.0'S 153°18.5'E), 22.04.2002, D.J. & L.V. Cook, L.RG. Cannon, K.B. & S.G. Sewell, 100% alc/Un. PARATYPES: QMG220582–220584 (WM), 100% alc/Un. OTHER MATERIAL FROM TYPE LOCALITY: QMG220585–220587 (CP), 100% alc/Fau. OTHER MATERIAL. From *Euastacus sulcatus*. Qld: [QMW18000 & 26656], QMG220588 (WM) Mosses Well, Spicers Gap, Main Ra. NP (28°04.0'S 152°26.3'E), 25.11.1991, K.B. Sewell & C. Lee, HW/Form/Hx; QMG220589 (WM), Form/Hx; QMG220590–220591 (WM), HW/Form/Hx; QMG220592 (WM) Glacial Acetic Acid/Hx; QMG220593 (WM), Form/Hx; [unreg. host, ident. Dr John Short, QM], QMG220594–220599 (CP), 1.09.1994, K.B. Sewell, Fau; [QMW18000 & 26656], QMG220600–220601 (LS[1,1,]), 1.09.1994, K.B. Sewell & C. Lee, Bouin/H&E; QMG220602 (LS[2]), HW/Form/H&E. [unreg. host, ident. Dr John Short, QM], QMG220603 (WM), Mt Huntley, at spring beside walking track nr summit, Main Ra. NP (28°08.8'S 152°26.6'E), 30.01.1993, G.B. Monteith, 70% alc/Un; QMG220604–220607 (CP), 70% alc/Fau.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus sulcatus* are: QMG220581 (H): B(2305 × 1163), LE(1632), PH(480 × 382), SD(602), PD(293); QMG220582 (P): B(2244 × 1081), LE(1571), PH(447 × 366), SD(545), PD(260); QMG220583 (P): B(1877 × 816), LE(1367), PH(366 × 309), SD(488), PD(215); QMG220584 (P): B(2162 × 1061), LE(1571), PH(439 × 350), SD(528), PD(268).

Reproductive System. Male. Cirrus: Shaft cone-shaped. Introvert cylinder to scoop-shaped; distal opening not obviously oblique. Swelling not observed. Selected cirrus measurements of specimens from *Euastacus sulcatus* from type locality are: QMG220585: S(179 × 59), I(24 ×

12), IS(na × na); QMG220586: S(154 × 41), I(25 × 10), IS(na × na); QMG220587: S(159 × 55), I(26 × 9), IS(na × na).

HOST. *Euastacus sulcatus*.

DISTRIBUTION. South-eastern Qld — from the the Macpherson Ra. region, near Mt Cougal; and from the Main Ra. NP, at Spicers Gap and Mt Huntley.

REMARKS. No large specimens were available from the type locality. Larger specimens were however available from the Spicers Gap locality and these displayed the typical, closely woven network of dorsal body pigment. The cirrus of this species is small and the introvert is tiny. The small size of the cirrus and cylindical nature of the introvert make *Temnosewellia minima* sp. nov. most similar to *T. flammula* sp. nov., but in *T. minima* sp. nov. the introvert is less flame-like. No introvert swelling was observed in *T. minima* sp. nov. but it is likely to be very narrow.

Temnosewellia muscalingulata sp. nov.
(Fig. 49A–D)

ETYMOLOGY. From *musca* = fly (Latin) and *lingua* = tongue (Latin, feminine, diminutive); a reference to the shape of the introvert being reminiscent of the proboscis of a fly.

MATERIAL. HOLOTYPE. QMG221034 (WM) from *Euastacus rieki* [QMW26644], Wragges Ck on Kosciusko Rd 5km NE Perisher Valley, Kosciusko NP, NSW (36°22.9'S 148°27.4'E), 18.03.2002, K.B. Sewell, 100% alc/Un. PARATYPES: QMG221035–221036 (WM), 100% alc/Un; [QMW26645] QMG221037–221038 (WM), 14.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Un. OTHERMATERIAL FROM TYPE LOCALITY: [QMW26645], QMG221039 (WM), 14.10.1991, L.R.G. Cannon & K.B. Sewell HW/Form/Un;], QMG221040–221042 (WM), HW/Form/Hx; [QMW26644], QMG221043–221046 (CP), 18.03.2002, K.B. Sewell, 100% alc/Fau; [QMW26645], QMG221047–221049 (CP), 14/10/1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Fau; QMG221050–221051 (LS[5,6]), 14.10.1991, L.R.G. Cannon & K.B. Sewell, Form/H&E. OTHER MATERIAL. From *Euastacus armatus*. VIC: [unreg. host, ident. Dr Susan Lawler, Latrobe University, VIC], QMG221162 (CP), Yackandandah Ck (36°14'S 146°57'S), 20.11.2001, S.H. Lawler & G.N. Edney, Fau.

From *Euastacus crassus*. VIC: [QMW26601], QMG221052–221060 (WM), Buchan R. in Native Dog Flat camping ground, Alpine NP (36°53.9'S 148°05.3'E), 19.03.2002, K.B. Sewell, S.H. Lawler & G.N. Edney, 100% alc/Un; QMG221061–221066 (CP), 100% alc/Fau.

FIG. 49. *Temnosewellia muscalingulata* sp. nov. from *Euastacus rieki*. A–D, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG221045, whole cirrus, scale = 500µm; B, QMG221045, introvert distal region, scale = 50µm; C, QMG221162, everted introvert distal region, scale = 50µm; D, QMG221048, everted introvert distal region, scale = 50µm.

From *Euastacus neodiversus*. VIC: [QMW26635], QMG221067–221071 (WM), Tarra R., 50 m above Tarra Falls, Tarra Valley NP (38°29'S 146°36'E), 10.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/MB/Hx; QMG221072–221077 (CP), HW/Form/Fau; QMG221078 (LS[4]), Form/H&E; QMG221079 (LS[5]), Bouin/H&E.

From *Euastacus woiwuru*. VIC: [QMW26669], QMG221080, 221082–221083 (WM), Dobsons Ck at crossing Alpine Rd nr junction with Mountain Hwy, Ferntree Gully SF, Dandenongs (37°52.3'S 145°20.0'E),

22.03.2002, K.B. Sewell, 100% alc/Un; [QMW26670], QMG221084–221086 (WM), 22.03.2002, L.R.G. Cannon & K.B. Sewell HW/Form/Hx; QMG221087–221091 (CP), 100% alc/Fau; QMG221092–221093 (LS[5,5]), Form/H&E. [NMVJ 4529], NMVF 93824 (WM) Creek between Mt Evelyn and Wandin North (37°47'S 145°23'E), Sep. 1963, J.R. Kane, unknown fixative/Hx; [unreg. host], NMVF 93825 (WM), Neerim, (37°58'S 145°57'E), 10.04.1906, S.W. Fulton, unknown fixative/carmine(?); NMVF 93826 (CP), unknown fixative/Fau.

From 'fresh water eray' VIC: [unreg. host], NMVF 93827–93833 (CP), Fern tree Gully (37°53'S 145°18'E), 18.02.1872, unknown fixation/Fau; NMVF 93834–93837 (LS[5,4,5,4]), unknown fixative/unknown stain[H&E(?)]; NMV 93892–93894 (WM), unknown fixation/Hx; NMV 93895–93896 (LS[5,5]), unknown fixation/Hx.

DESCRIPTION. Charaeteristies of genus; pattern of body pigment typieal. Selected body measurements of type speeimens from *Euastacus rieki* are: QMG221034 (H): B(4039 × 2917), LE(2652), PH(512 × 756), SD(1179), PD(610); QMG221035 (P): B(3835 × 2836), LE(2795), PH(545 × 805), SD(1220), PD(561); QMG221036 (P): B(3917 × 3101), LE(2693), PH(593 × 862), SD(1187), PD(545); QMG221037 (P): B(3509 × 1979), LE(2265), PH(366 × 618), SD(602), PD(341); QMG221038 (P): B(3774 × 1958), LE(2530), PH(407 × 626), SD(846), PD(390).

Reproductive System. Male. Cirrus: Shaft eone-shaped. Introvert cylinder-shaped except for flared distal region; distal opening oblique. Spines in flared distal region of introvert elearly larger than those in proximal eylinder-shaped region. Very long, thin spines (about 140 long) attaehed on, or just distal to, introvert base and projeet distally. Swelling uneven, very narrow(?). Seleeted eirrus measurements of speeimens from *Euastacus rieki* from type loeality are: QMG221045: S(677 × 102), I(187 × 26), IS(na × na); QMG221046: S(448 × 77), I(165 × 27), IS(na × na); QMG221049: S(359 × 38), I(177 × 25), IS(na × na).

HOSTS. *Euastacus armatus*, *E. crassus*, *E. neodiversus*, *E. rieki*, *E. woiwuru*.

DISTRIBUTION. Southern NSW — from the Koseiusko NP region. Northern VIC — from the Alpine NP. Southern VIC — from the Tarra Valley NP region; and the Melbourne region.

REMARKS. A widespread worm with a large, very slender eirrus and a unique introvert that elearly distinguishes this speeies from all others in the genus. The extremely long spines attached near the introvert base ean only be elearly seen when the introvert is at least partially everted.

Temnosewellia possibilitas sp.nov.
(Fig. 50A–D)

ETYMOLOGY. From *possibilitas* = possibility (Latin); for the possibility of this species being the 'variety' of *Temnosewellia fasciata* described by Haswell (1893).

MATERIAL. HOLOTYPE. [unreg. host], AMW28703 (WM), from *Astacopsis serratus* [= *Euastacus* spp.], Leura, Blue Mountains (33°43'S 150°19'E), unknown date/collector/fixative [speeimens ident. W.A. Haswell.]; unknown fixative/Un. PARATYPE: AMW28704 (WM), unknown fixative/Un. OTHER MATERIAL FROM THE TYPE LOCALITY: AMW28705–28707 (WM), unknown fixative/Un; AMW28708–28711 (CP), unknown fixative/Fau. OTHER MATERIAL. From *Euastacus bispinosus*. VIC: [NMVJ 875], NMV F 93885– F 93886 (WM), Glenelg R., VIC (37°17'S 141°16'E), 1941, E.M. Clarke, unknown fixative/Hx; NMV F 93887–93890 (CP), unknown fixative/Fau; NMV F 93891 (LS[6]), unknown fixative/H&E.

DESCRIPTION. Charaeteristies of genus; pattern of body pigment typical. Seleeted body measurements of type speeimens from *Astacopsis serratus* [*Euastacus* spp.] are: AMW28703 (H): B(4468 × 2122), LE(3162), PH(663 × 816), SD(1073), PD(569); AMW28704 (P): B(2407 × 1326), LE(1918), PH(431 × 537), SD(748), PD(374).

Reproductive System. Male. Cirrus: In general form as figured by Haswell (1893: plate XIII, fig. 14). Shaft eone-shaped. Introvert seoop-shaped with distal region more rapidly tapering as figured by Haswell (1893: plate XIII, fig. 14); distal opening slightly oblique. Swelling near even, extends proximally slightly past introvert, about equally on both sides. Seleeted eirrus measurements of speeimens from *Astacopsis serratus* [= *Euastacus* spp.] are: AMW28708: S(641 × 242), I(154 × 47), IS(12 × 12); AMW28709: S(581 × 246), I(159 × 53), IS(12 × 18); AMW28710: S(609 × 218), I(154 × 47), IS(na × na); AMW28711: S(641 × 226), I(157 × 49), IS(na × na).

HOSTS. *Astacopsis serratus* [= *Euastacus* spp.], *Euastacus bispinosus*.

DISTRIBUTION. Mid eastern NSW — from the Blue Mountains NP region. South-western VIC — from the Glenelg R.

REMARKS. Haswell (1893) deseribed and figured the eirrus of a worm he regarded as a variety of *Temnosewellia fasciata*. We believe it

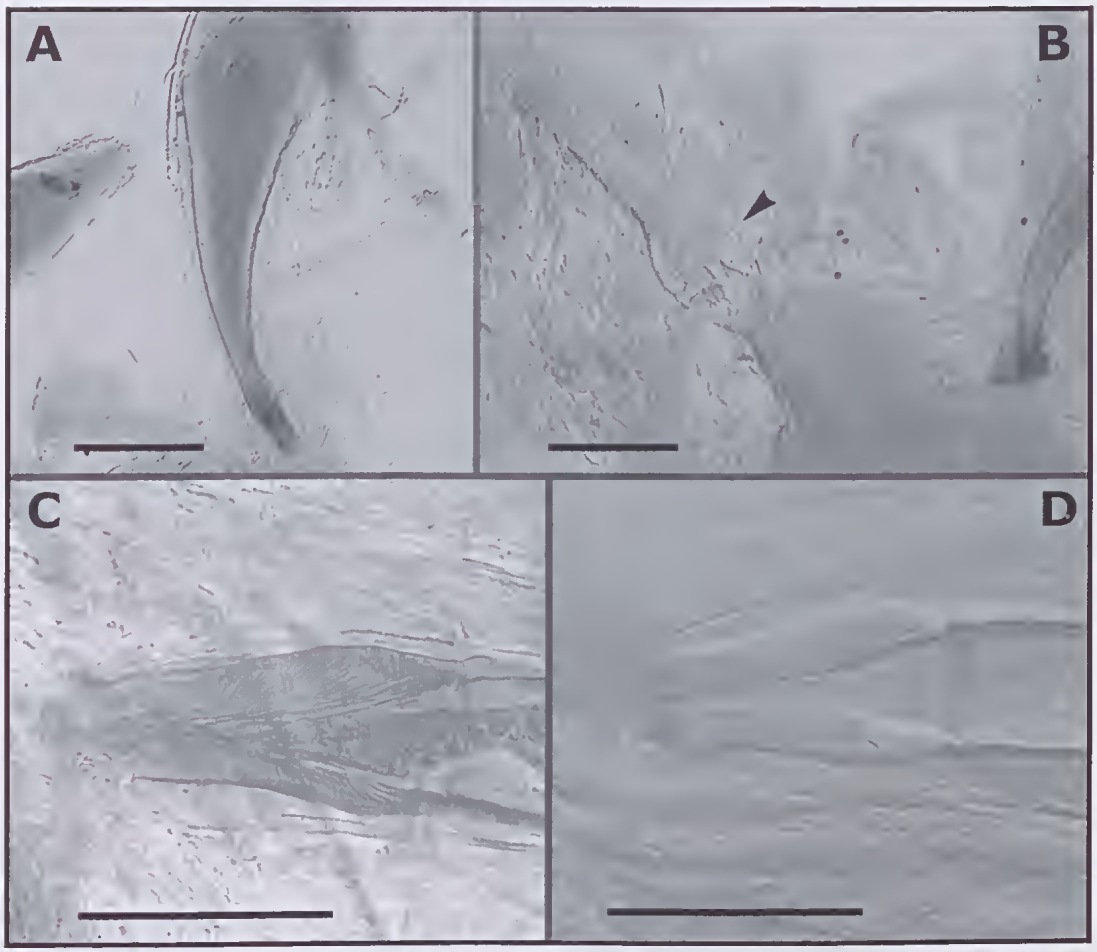


FIG. 50. *Temnosewellia possibilitas* sp. nov. A–D, Nomarski interference contrast photomierographs of Faure's preparations. A, AMW29708 from *Astacopsis serratus* [= *Euastacus* sp.] whole cirrus, scale = 250µm. B, AMW28710, from *Astacopsis serratus* [= *Euastacus* sp.], partly everted introvert and weakly selerotised, compartmentalised vagina (arrowhead), scale = 250µm; C, AMW28709, from *Astacopsis serratus* [= *Euastacus* sp.], cirrus introvert, scale = 100µm; D, NMVF93888 from *Euastacus bispinosus*, cirrus introvert, scale = 100µm.

probable that the present species and Haswell's 'variety' are one and the same. Haswell (1893) described the variety as occuring 'together with' *Temnosewellia fasciata* and 'closely resembling the young of that species'. We did not find the two species together but we did find *T. fasciata* on *Euastacis australasiensis* collected just above Wentworth Falls, which is within five km of Leura from where the present species was collected. According to Morgan (1997) this region of the Blue Mountains is inhabited by only two *Euastacus* species, *E. australasiensis* and *E. spinifer*. Haswell (1893) identified as *T. fasciata* the specimens examined here that were collected from *Astacopsis serratus* [= *Euastacus* spp.] from Leura, Blue Mountains. The cirrus of these specimens was revealed by Faure's medium to be similar to that of the form figured by Haswell (1893: plate XIII fig. 14). In particular, the introvert has a distinctive narrowed distal region. Haswell (1893) described the cirrus as closely resembing that of *Temnohaswellia novaezealaudiae* in possessing 'a small introvert with exceedingly fine spines'.

Haswell (1893) described the vagina as having 'a zone or circlet of what appeared to be rudimentary chitinous teeth'. We did not observe anything resembling teeth in the distal vagina

FIG. 51. *Temnosewellia unguiculus* sp. nov. from *Euastacus claytoni*. A-B, Nomarski interference contrast photomicrographs of Faure's preparations. A, QMG221024, whole cirrus, scale = 100µm; B, QMG221024, introvert showing the introvert base (arrowhead), scale = 50µm.

of *Temnosewellia possibilitas* sp. nov. The vagina of this species is however more tightly compartmentalised than typical of other species examined here (Fig. 50B).

This species has a cirrus most similar to those of *Temnosewellia fax* sp. nov. and *T. comythus* sp. nov., but larger and the introvert swelling is even (not uneven) and extends only a short distance proximally, not a medium to long distance as in those two species.

We tentatively include in this species specimens collected from *Euastacus bispinosus* from the Glenelg R. VIC noting that the introvert is slightly shorter in these specimens. We recognise that their locations are far apart.

Temnosewellia unguiculus sp. nov.
(Fig. 51A, B)

ETYMOLOGY. From *unguiculus* = small claw, talon or fingernail (Latin, masculine, diminutive); a reference to the small size of the cirrus and the resemblance of the introvert to a hooked claw.

MATERIAL. HOLOTYPE. QMG221011 (WM), from *Euastacus claytoni* [QMW26599], Lowden Ck, in Lowden FP picnic area, Tallaganda SF, NSW (35°30.8'S 149°36.2'E), 17.10.1991, L.R.G. Cannon & K.B. Sewell, HW/Form/Hx. PARATYPES: QMG221012 (WM), HW/Form/Hx; QMG221013–221014 (WM) HW/Form/Un; [QMW26600], QMG221015 (WM), 16.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un. OTHER MATERIAL FROM TYPE LOCALITY: [QMW26599], QMG221016–221018 (WM), L.R.G. Cannon & K.B. Sewell, HW/Form/Un; [QMW26600], QMG221019–221022 (WM), 16.02.2002, K.B. Sewell & R.D. Sewell, hot Bouin/Un; QMG221023 (CP) 70% alc/Fau; [QMW26599], QMG221024–221026 (CP), L.R.G. Cannon & K.B. Sewell, HW/Form/Fau; [QMW26600], QMG221027–221031 (CP), 16.02.2002, K.B. Sewell & R.D. Sewell, 70% alc/Fau; [QMW26599], QMG221032–221033 (LS[7,6]), L.R.G. Cannon & K.B. Sewell, HW/Form/H&E.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical. Selected body measurements of type specimens from *Euastacus claytoni* are: QMG221011 (H): B(4019 × 2183), LE(2693), PH(439 × 756), SD(886), PD(390); QMG221012 (P): B(4304 × 2346), LE(2978), PH(480 × 752), SD(967), PD(496); QMG221013

(P): B(4060 × 2203), LE(2815), PH(512 × 691), SD(951), PD(447); QMG221014 (P): B(4794 × 2468), LE(3203), PH(528 × 748), SD(935), PD(463); QMG221015 (P): B(4753 × 2611), LE(3284), PH(691 × 748), SD(940), PD(472).

Reproductive System. Male. Cirrus: Shaft cone-shaped, with strongly curved distal region. Introvert lacks spined region(?), scoop-shaped, introvert longer side strongly curved; distal opening very oblique. Swelling uneven, not extending past introvert base on either side(?). Selected cirrus measurements of specimens from *Euastacus claytoni* from type locality are: QMG221024: S(148 × 85), I(77 × 30), IS(na × na); QMG221025: S(148 × 71), I(77 × 30), IS(na × na); QMG221026: S(183 × 116), I(77 × 35), IS(na × na); QMG221027 S(173 × 116), I(83 × 33), IS(na × na); QMG221029 S(195 × 132), I(78 × 33), IS(na × na).

HOST. *Euastacus claytoni*.

DISTRIBUTION. South-eastern NSW — from Lowden Ck, Tallaganda SF.

REMARKS. The morphology of the cirrus is unique and serves to distinguish this species. The cirrus is small but has an extremely distinctive introvert shape resulting from a long and strongly curved longer side. The fine details of the introvert are difficult to resolve. The introvert swelling was difficult to distinguish. Spines were not observed, but longitudinal rows of striae reminiscent of spines are present.

Temnosewellia sp.

MATERIAL. From *Euastacus neohirsutus*. NSW: [QMW26651], QMG220861 (Middle Ck trib., beside road 6km upstream from Corritts Water, NSW (30°21.4'S 152°29.1'E), 15.02.1992, K.B. Sewell & S.G. Sewell, HW/Form/Hx; QMG220866 (CP) [juvenile], HW/Form/Fau; QMG220867–220868 (LS[1,2]), Form/H&E.

DESCRIPTION. Characteristics of genus; pattern of body pigment typical.

REMARKS. This species occurred with *Temnosewellia flammula* sp. nov. but has a clearly different and larger cirrus introvert (although only immature worms were available for study). All the specimens examined had well developed body pigment. In the absence of mature specimens we are reluctant to describe this species formally.

DISCUSSION

The assertion more than 10 years ago by Cannon (1991) that the Australasian region is the centre of diversity of the Temnocephalida is supported here by the addition of 10 new species of *Temnohaswellia* and 31 new species of *Temnosewellia* all from hosts in the crayfish genus *Euastacus* collected from eastern Australia. Furthermore, the prediction by Cannon & Sewell (1994) that the large, brown-pigmented worms with 5 tentacles that inhabit the surface of most *Euastacus* spp. belonged to many species, is confirmed. These species, not all of which are equally pigmented, were recorded from the complete extent of the range of *Euastacus*, from the base of Cape York (NE Qld) to the Grampians NP in Vic.

We were able to confirm the validity of *Temnohaswellia comes* (Haswell, 1893) and the poorly described *Temnoshaswellia simulator* (Haswell, 1924) which previously were the only known members of the genus described as occurring on *Euastacus* species. The validity of *Temnosewellia fasciata* (Haswell, 1888), the first temnocephalan species recorded from *Euastacus*, was confirmed, and we consider that *T. possibilitas* is very likely the 'variety' of *T. fasciata* reported by Haswell (1893).

The present study and recent taxonomic studies by Cannon (1993), Cannon & Sewell (1995, 2001), Sewell & Cannon (1998a) together provide strong evidence that eastern Australia is in fact the centre of diversity for the worms, although it must be remembered that the temnocephalan fauna of New Guinea has been little studied.

Molecular studies associated with the present study will allow in-depth analyses of species and biogeography. Nevertheless, some interesting related factors have emerged that warrant discussion here. Many *Temnohaswellia* species are found on numerous species of hosts, and the distribution of a host is a more reliable clue than its species identity in helping to identify worms, i.e for most Australian *Temnohaswellia* species, geography is more significant than host. Several species of *Temnohaswellia*, most notably *T. comes*, have extensive geographical ranges as well as very low host specificity. The single New Zealand species, *Temnohaswellia novaezealandiae*, is restricted to the two available New Zealand crayfish hosts, but on these has a wide geographical distribution. In contrast, for most Australian *Temnosewellia* spp., the geographical location, the

distribution and identity of the *Enastacus* crayfish host(s) are all useful taxonomic guides.

Temnosewellia species are certainly not limited to hosts of the genus *Enastacus*, or even to parastacid crayfish hosts. Indeed, species of *Temnosewellia* have been reported in Australia from *Cherax* and *Engaeus* crayfish, as well as the burrowing isopod, *Phreatoicopsis terricola*, and from freshwater crabs (*Holthusiana*) and freshwater shrimp (*Macrobrachium*, *Caridina* and *Paratya*) (Cannon, 1993; Cannon & Sewell, 2001; Haswell, 1893; Williams, 1980). Moreover, the genus extends beyond Australia: *Temosewellia semperi* is a symbiont of freshwater crabs in the region from Indonesia to India, and *T. ronxi* is recorded from *Cherax* crayfish from the Aru Isands, just to the north of Australia, as well as from cultured crayfish in Australia (Cannon, 1991; Merton, 1914; Weber, 1889). Translocation of cultured Australian *Cherax* crayfish, particularly the marron, *C. tenuimanus*, has resulted in the spread of *Temnosewellia* species globally. In particular, *T. minor* has been reported from as far afield as South Africa, Japan and Europe (Mitchell & Kok 1988; Avenant-Oldewage, 1993; Oki et al., 1995; Xylander, 1997; Cannon & Sewell, 2001).

At several localities different *Temnohaswellia* species were observed to co-occur on the same individual host specimen. Similarly, different *Temnosewellia* species were observed to co-occur on the same individual host specimen. Also co-occurrence of the same host species by different genera of temnocephalans at a single locality has been widely reported for over 100 years (see for example, Haswell 1888, 1893). This raises questions about niche separation and competition, and signals the need for careful and detailed examination to confirm the identification of temnocephalan species.

We know too that host specifity is variable. While co-occurrences of different host genera are sometimes found with probable sharing of worms (e.g. *Temnosewellia cestus*), much remains to be learned of the ecology of these worms.

The absence of body pigment from most species of *Temnohaswellia*, the number of tentacles and the small size of the worms makes the genus readily identifiable in the field or laboratory. In contrast, pigment is usual in *Temnosewellia*, those temnocephalans with 5 tentacles, raising questions as to its function. However, the far north Queensland worms all lack body pigment. The group of non–pigmented 'white' worms i.e. *Temnosewellia alba, T. arga, T. argilla, T. albata, T. aspra, T. argeta* and *T. aphyodes* all have a similar cirrus and introvert morphology but show, in the order listed, a general decrease in overall size of the cirrus. In most other *Temnosewellia* species, some differences in body pigments were recorded, but age-related variation in pigment density was frequently observed within species and this suggests that the character should be used with caution.

The vagina of *Temnohaswellia*, unlike that of most other genera of temnocephalans, has sclerotised teeth whose arrangement has proven the most valuable character to discriminate species in the present study. Thus, our species descriptions for members of this genus rely more heavily on descriptions of the sclerotised components of the vagina than in our previous publications (e.g. Cannon & Sewell, 1995, 2001; Sewell & Cannon, 1998a). As a consequence, the species descriptions in the present paper are more succinct than those previously published.

Faure's medium revealed the gross morphology of the sclerotised components of the vagina more easily than techniques used previously, while also revealing the morphology of the cirrus. The function of the sclerotised unspined region that collars the distal introvert (i.e. the 'unspined distal region') of most Australian species of *Temnohaswellia* remains unknown. The sclerotisation may protect the smaller spines of the introvert distal region from the large teeth in the outer region of the distal vagina during copulation (or self-impregnation if it occurs). Similarly, the structure and function of the 'introvert swelling' is not yet known. Sewell (1998) postulated that for the Craspedellinae the introvert swelling assists to maintain the rigidity of the introvert during mating and serves to elastically return the introvert to the inverted state and allows the spines to be withdrawn safely after mating. A study that includes the use of transmission electron microscopy would most likely be required to elucidate the structure and function of the introvert swelling. Furthermore, until studies are conducted on growth we shall not know if the vaginal teeth (number, distribution and size) change with age.

The species descriptions provided here are based primarily on differences in the sclerotised reproductive structures. In *Temnohaswellia* there is wide variation in the vagina and often presence of vaginal teeth. The distal vagina of *Temnosewellia*, however, lacks teeth. Indeed, the

distal vagina of *Temnosewellia* species is typical of most temnocephalans in that it has only a slightly ruffled appearance. It is the great variation in cirrus morphology which is particulary useful in discriminating *Temnosewellia* spp.

Our field collecting in Australia was largely limited to the type localities of many of the *Euastacus* hosts. We are therefore confident that further examination of *Euastacus* hosts from across their distributions will reveal a greater diversity of both *Temnohaswellia* and *Temnosewellia.*

Much remains to be learned of the reproduction in these worms including the role of spermatophores mentioned by Haswell (1924) and the mode of production of the egg capsules which are of two forms: (1) those that stand on end on a pedunele and (2) those cemented flat to the host caparace with an upper sclerotised 'wisp'. Because more than one species in one genus, as well as species in different genera, can inhabit the one host it has usually not been possible to reliably determine which egg capsules belong to which temnocephalans. Perhaps now this aspect of temnocephalans can reveal further clues as to their diversity.

We have included the pattern of the epidermal mosaic in the genus taxonomic descriptions. Williams (1975) first reported that temnocephalans have a pattern of syncytial plates and Sewell & Cannon (1995) suggested that the pattern of the mosaic may have value as a taxonomic character. The pattern of the mosaic has subsequently been established to be most valuable as a taxonomic character at the level of higher taxa e.g. order and family. Joffe & Cannon (1998) mapped the mosaics of various families of temnocephalans, and later, they (Cannon & Joffe, 2001) established that an epidermis made of multiple syncytial plates is a synapomorphy for the Temnocephalida. Damborenea & Cannon (2001) examined *Temnocephala* from South America and reported the post-tentacular syncytia are paired dorsal plates which each enclose an exeretory pore, a character they used to help define the genus. Within genera the pattern of the mosaic has been shown not always to be useful to distinguish species, due to lack of consistent variation in adults worms (Joffe & Cannon, 1998; Sewell 1995). Some ontogenic and occasional within species variation has been observed for some species (Joffe & Cannon, 1998).

In the present study, we examined in detail the mosaic for only two species, *Temnohaswellia comes* and *Temnosewellia cypellum* from *Euastacus spinifer*, primarily to demonstrate the patterns described by Joffe & Cannon (1998), for three putative species from *Euastacus sulcatus* (of which two are now identified as *Temnohaswellia comes* and *Temnosewellia minima*). Examination of the pattern of the mosaic of other species of *Temnohaswellia* and *Temnosewellia* from *Euastacus* hosts may reveal consistent differences in the pattern between species. There is some evidence for this. Joffe & Cannon (1998) reported that for *Temnohaswellia comes* from *Euastacus sulcatus* collected at Spicers Gap, the nephridiopores lie within the post-tentacular syncytium, whereas in another species, *Temnohaswellia* sp., collected from the same host and locality, the nephridiopores open between the post-tentacular syncytium and the body syncytium and occasionally were nearly fully separated from the body syncytium. We were unable to confirm the identity of the specimens of *Temnohaswellia* sp. examined by Joffe & Cannon (1998) but it is very likely that the species was *T. simulator* given that this species was found to co-inhabit the crayfish host at this locality in the present study.

We hope that the present work will provide improved ease with which species of *Temnohaswellia* and *Temnosewellia* may now be identified and will lead to increased scientific interest in these fascinating worms, particularly with regards to the nature of their association with their *Euastacus* hosts.

ACKNOWLEDGEMENTS

The support of the Queensland Museum (QM) and James Cook University (JCU) is gratefully acknowledged. Special thanks are due to Dr Rob Adlard (QM) who cheerfully made available laboratory space and equipment for KBS. We thank the Australian Research Council for a grant (DP0209237) which funded the study in 2002–3 and the Australian Biological Resources Study for a grant (87/5909) that funded many of the initial collections of crayfish and worms conducted prior to 2002.

We are grateful to museum staff of the state museums of New South Wales and Victoria who assisted greatly in appraising collections and records of crayfish to assist in locating suitable collection sites. Dr Penney Berents of the Australian Museum, Sydney (AM), located and organised the loan of type material of *Temnohaswellia comes*. Kate Attwood (AM) and Chris Rowley from Museum Victoria (NMV) assisted with registration of specimens.

We thank the numerous officers of National Parks, Forestry and Fisheries in Queensland, New South Wales, Australian Capital Territory and Victoria, who provided collection permits and occasionally field assistance in locating crayfish habitats. We also are indebted to Queensland Native Title Claimants for their willing permission to allow collections within their traditional country. We are particularly indebted to The Jinibara People (Queensland Native Title Claimants (QC98/045) and the Gubbi Gubbi Land and Cultural Association for their willing permission to allow collections within their traditional country.

We particularly thank Mr Doug Cook (QM) and Dr L. Cook who provided ready access to their wonderful rainforest property for collection of crayfish. Dr Geoff Monteith (QM) provided many crayfish and worms specimens and immeasurably valuable advice related to accessing difficult field sites. Mr Lewis Roberts capably guided our collection party up Mt Finnigan. Dr Mark Ponniah kindly provided specimens of worms from *Euastacus hystricosus*. Dr Rob Adlard (QM), Dr Mal Bryant (QM), Mr Geoffrey Edney, Dr Dinah Hansman, Dr Susan Lawler (Latrobe University), Mr Ryan Sewell and Mrs Susan Sewell all provided considerable and valuable assistance in the field at various times.

Peter Davie and John Short (QM) cheerfully provided expert identification of crayfish. Most of the stained specimens of worms from the QM collections mentioned here that are either stained wholemounts or serial sections, were prepared expertly by Mrs Zeinab Khalil and Mrs Christine Lee. Many of the NMV specimens mentioned here were expertly either wholemounted, sectioned or mounted in Faure's medium by Dr Boris Joffe, then of the Zoological Institute, St Petersburg, Russia.

Crayfish were collected under the following permits: Queensland Parks and Wildlife Service – Scientific Purposes Permit and Permit to Take, Use Keep or interfere with cultural of natural resources: F1/000485/02/SAA; State of Qld Department of Primary Industries Forestry – Sales Permit: 20010302; Queensland Environment Protection Agency – State Forests, Timber Reserves and other State lands: 1715 and TWB/07/2002; Queensland Environment Protection Agency (Eco-access) Take, Use Keep or Interfere with Cultural or Natural Resources Permit: WITK00468802; Queensland Parks and Wildlife Service – Permit to Collect Biological or Geological Material from Queensland State Forest, Timber Reserves and other state Lands: SF 1715; NSW Fisheries – Scientific Research Permits TO1/007 and PO1/0009; P03/0099; NSW State Forests – Special Purposes Permit: 05539, 05670 and 15257; NSW National Parks and Wildlife Service – Scientific Research License: B2348 and S10998; Environment ACT, Environmental Protection – Letter of approval to collect in Namadgi NP; VIC Department of Sustainability and Environment Research Permit #10002702.

Finally, we thank sincerely two peer reviewers of this manuscript for their thoughtful and thorough perusal.

LITERATURE CITED

AVENANT-OLDEWAGE, A. 1993. Occurrence of *Temnocephala chaeropsis* on *Cherax temimanus* imported into South Africa, and notes on its infestation of an indigenous crab. South African Journal of Seience 89: 427–428.

CANNON, L.R.G. 1986. Turbellaria of the World: A Guide to Families and Genera. Queensland Museum: Brisbane.

1991. Temnocephalan symbionts of the freshwater crayfish *Cherax quadricarinatus* from northern Australia. Hydrobiologia 227: 341–347.

1993. New temnocephalans (Platyhelminthes): ectosymbionts of freshwater crabs and shrimp. Memoirs of the Queensland Museum 33: 17–44.

CANNON, L.R.G. & JENNINGS, J.B. 1987. Occurrence and nutritional relationships of four ectosymbiotes of the freshwater crayfishes *Cherax dispar* Riek and *Cherax punctatus* Clark (Crustacea: Decapoda) in Queensland. Australian Journal of Marine and Freshwater Research 38: 419–427.

CANNON L.R.G. & JOFFE, B.I. 2001. Chapter 9, Temnocephalida, Pp. 83–91, *in*, Littlewood, D.T.J. & Bray, R.A. (Eds), Interelationships of the Platyhelminthes (Taylor & Francis: London).

CANNON, L.R.G. & SEWELL, K.B. 1994. Symbionts and biodiversity. Memoirs of the Queensland Museum 33: 36–40.

1995. Craspedellinae Baer, 1931 (Platyhelminthes: Temnocephalida) ectosymbionts from the branchial chamber of Australian crayfish (Crustacea: Parastacidae). Memoirs of the Queensland Museum 38: 397–418.

2001. A review of *Temnosewellia* (Platyhelminthes: Temnocephalida) ectosymbionts of *Cherax* (Crustacea: Parastacidae) in Australia. Memoirs of the Queensland Museum 46: 385–389.

COUGHRAN J. 2002. A new species of the freshwater crayfish genus *Euastacus* (Decapoda: Parastacidae) from Northeastern New south Wales, Australia. Records of the Australian Museum 54: 25–30.

DAMBORENEA, C. & CANNON, L.R.G. 2001. On neotropical *Temnocephala* (Platyhelminthes). Journal of Natural History 35: 1103–1118.

FYFE, M.L. 1942. The anatomy and systematic position *of Temnocephala novaczealanadiac* Haswell. Transactions of the Royal Society of New Zealand 72: 253–267.

HASWELL, W.A. 1888. On *Temnocephala*, an aberrant monogenetic trematode. Quarterly Journal of Mieroscopical Science 28: 279–302, pls 20–22.

1893. A monograph of the Temnocephaleae. Linnean Society of New South Wales, Macleay Memorial Volume: 93–152.

1900. Supplement to a 'Monograph of the Temnoeephalcae'. Proceedings of the Linnean Society of New South Wales 25: 430–435.

1924. Critical notes on the Temnocephaloidea. Proceedings of the Linnean Society of New South Wales 49: 509–520.

HICKMAN, V.V. 1967. Tasmanian Temnocephalidea. Papers and Proceedings of the Royal Society of Tasmania 101: 227–250.

JOFFE, B.I. & CANNON L.R.G. 1998. The organisation and evolution of the mosaic of the epidermal syncytia in the Temnocephalida (Platyhelminthes: Neodermata). Zoologischer Anzeiger 237: 1–14.

MERTON, H. 1914. Beiträge zur Anatomie und Histologie von *Temnocephala*. Abhandlungen Senckenbergische Naturforschende Gesellschaft 35: 1–58.

MITCHELL, S.A. & KOK, D.J. 1988. Alien symbionts introduced with imported marron from Australia may pose a threat to aquaculture. Suid-Afrikaanse Tydskrif vir Wetenskap 84: 887–888.

MORGAN, G.J. 1986. Freshwater crayfish of the genus *Euastacus* Clark (Decapoda, Parastacidae) from Victoria. Memoirs of the Museum of Victoria 47: 1–57.

1988. Freshwater crayfish of the genus *Euastacus* Clark (Decapoda, Parastacidae) from Queensland. Memoirs of the Museum of Victoria 49: 1–49.

1989. Two new species of the freshwater crayfish *Euastacus* Clark (Decapoda: Parastacidae) from isolated high country of Queensland. Memoirs of the Queensland Museum 27: 555–562.

1991. The spiny crayfish of Queensland. The Queensland Naturalist 31: 29–36.

1997. Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. Records of the Australian Museum, Supplement 23: 1–109.

OKI, I., TAMURA, S., TAKAI, M. & KAWAKATSU, M. 1995. Chromosomes of *Temnocephala minor*, an ectosymbiotie turbellarian on Australian crayfish found in Kagoshima Prefecture, with karyological notes on exotic turbellarians found in Japan. Hydrobiologia 305: 71–77.

PEREIRA, A.C. & CUOCOLO, R. 1941. Estudos sôbre 'Temnocephalidae Monticelli, 1899', com estabelecimiinto de dois novos gêneros Australianos e deserição de daue novas espécies neotrópicas. Arrquivos do Instituto Biologio, São Paulo 12: 101–127.

SEWELL, K.B. (1998). *Craspedella pedum* (Craspedellinae: Temnocephalida): a model for ectosymbiosis. Unpub. PhD thesis, The University of Queensland 307 pp.

SEWELL, K.B. & CANNON, L.R.G. 1995. A scanning electron microscope study of *Craspedella* sp. from the branchial chamber of redclaw crayfish, *Cherax quadricarinatus*, from Queensland, Australia. Hydrobiologia 305: 151–158.

1998a. New Temnocephalans from the branchial chamber of Australian *Euastacus* and *Cherax* crayfish hosts. Proceedings of the Linnean Society of New South Wales 119: 21–36.

1998b. The taxonomic status of the ectosymbiotic flatworm *Didymorchis paranephropis* Haswell. Memoirs of the Queensland Museum 42: 585–595.

SHORT, J.W. & DAVIE, P.J.F. 1993. Two new species of freshwater crayfish (Crustaeea: Decopoda: Parastacidae) from northeastern Queensland rainforest. Memoirs of the Queensland Museum 34: 69–81.

UPTON, M.S. 1993. Aqueous gum-chloral slide mounting media: an historical overview. Bulletin of Entomological Research 83: 267–274.

WEBER, M. 1889. Über *Temnocephala* Blanchard. Zoologische Ergebnisse einer Reise in Niederlandische Ostindien. 1: 1–29.

WILLIAMS, J.B. 1975. Studies on the epidermis of *Temnocephala*. I. Ultrastructure of the epidermis of *Temnocephala novae-zealandiae*. Australian Journal of Zoology 23: 321–331.

1980. Morphology of a species of *Temnocephala* (Platyhelminthes) ectocommensal on the isopod *Phreatoicopsis terricola*. Journal of Natural History 14: 183–199.

1982. Studies on the epidermis of *Temnocephala*. VI. Epidermal topography of *T. novaezealandiae* and other Australasian Temnocephalida, with notes on microvillar and coated vesiele function and the evolution of a cuticle. Australian Journal of Zoology 30: 375–390.

1985. Studies on the epidermis of *Temnocephala*. VII. The basal region with comments on 'membrane flow'. Australian Journal of Zoology 33: 413–423.

XYLANDER, W.E.R. 1997. Epidermis and sensory receptors of *Temnocephala minor* (Platyhelminthes, Rhabdocoela, Temnocephalida): and electron microscope study. Zoomorphology 117: 147–154.

A NEW SPECIES OF THE NEW CALEDONIAN GENUS *SPHODROSOMUS* PERROUD (COLEOPTERA: CARABIDAE: PTEROSTICHINI)

KIPLING W. WILL

Will, K.W. 2006 11 10: A new species of the New Caledonian genus *Sphodrosomus* Perroud (Coleoptera: Carabidae: Pterostichini). *Memoirs of the Queensland Museum* **52**(1): 281-285. Brisbane. ISSN 0079-8835.

Sphodrosomus monteithi sp. nov. is described with its type locality Mt Panié refuge, New Caledonia. A key to adults of *Sphodrosomus* and additional descriptive and locality information for the only other species in the genus, *S. saisseti* Perroud & Montrouzier, are provided. ❐ *New species, Sphodrosomus, flightless beetle.*

Kipling W. Will, 137 Mulford Hall, ESPM Department - Organisms & Environment Division, University of California Berkeley, CA 94720. USA. (Email: kiplingw@nature.berkeley.edu); *28 February 2006.*

The preeinctive New Caledonian genus *Sphodrosomus* was described by Perroud (in Perroud & Montrouzier (1864: 58). There has been no recent explicit classification of *Sphodrosomus* but it is generally placed in catalogues near other New Caledonian, New Zealand and Australian genera of Pterostichini (Csiki, 1929, 1930; Lorenz, 2005a, b). Tschitschérine (1901) did consider their quadrisetose ligula and elongate appendages distinct enough to designate a tribal-level taxon Sphodrosomini, however, most authors place the genus within a broad coneept of Pterostichini. The habitus of *Sphodrosomus* species is similar to members of *Psegmatopterus* Chaudoir, *Platysmodes* Fauvel and *Notonomus* Chaudoir. DNA sequenee data (28s rDNA, K.Will & D. Maddison unpubl.) suggests that these taxa and other genera in Moore's (1965) *Notonomus* series may form a monophyletic group. Recent fieldwork by the Queensland Museum in New Caledonia revealed a second species of *Sphrodrosomus* that is deseribed below.

METHODS

Disseetion methods for male and female genitalia and defensive glands, measurements and descriptive terms follow Will (2002). Images were taken using a Microptics XLT digital imaging system.

ABBREVIATIONS. QM, Queensland Museum, Brisbane; MNHN, Muséum National d'Histoire Naturelle, Paris; BMNH, Natural History Museum, London; EMEC, Essig Museum of Entomology Colleetion. University of California, Berkeley, CA.; NMW, Naturhistorisches Museum, Vienna.

TAXONOMY

Sphrodosomus Perroud

Perroud & Montrouzier (1864: 58).

TYPE SPECIES. *Sphodrosomus saisseti* Perroud (in Perroud & Montrouzier (1864: 59) by monotypy.

NOMENCLATURE. In the original description Perroud & Montrouzier (1864) intended to honor Governor Saisset of New Caledonia with a patronym. However, they spelt the specific epithet 'seisseti' and in the dedication referred to 'Son Excellence le gouverneur Seisset'. The spelling of the specific epithet was changed by Fauvel (1882: 273) to 'saisseti' without explanation. Fauvel's ehange, however, is not an emendation according to the criteria set by article 33.2.1 of the code (ICZN 1999). The ICZN is elear that prevailing usage should then determine the correct spelling (article 33.3.1). In this ease all subsequent authors have used 'saisseti'. Additionally, there has been variation in the attribution of the genus to either Perroud & Montrouzier (and variation in the spelling of Montrouzier as Montrousier) or only Perroud. As discussed by Perroud in the opening letter to their paper, the specimens were sent to Perroud by Montrouzier with notes and tentative identifications. Perroud did not follow Montrouzier's generic placements and described new genera without any obvious input from Montrouzier. In the present case Perroud noted that the name given by Montrouzier was '*Pamborus seisseti*'. Therefore the attribution of *Sphodrosomus* is considered to be Perroud in Perroud & Montrouzier (1864).

GENERIC DIAGNOSIS. Distinguished from other austral pterostichines by the ovate form of the

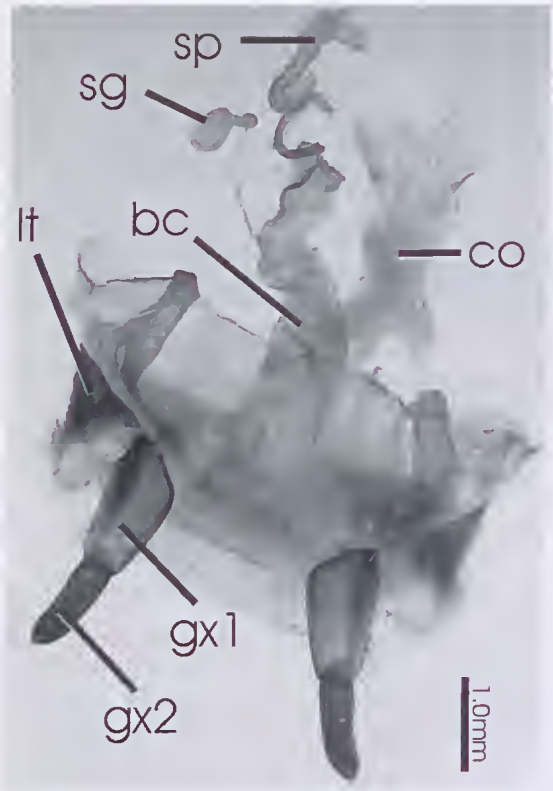


FIG. 3. Female reproductive tract of *Sphodrosomus monteithi*, ventral view. bc, bursa copulatrix; co, common oviduct; gx1, gonocoxite-1; gx2, gonocoxite-2; lt, laterotergite IX; sg, spermathecal gland; sp, spermatheca.

of setae in male and two pairs in female. Aedeagus (Fig. 2) with dorsal ostium; parameres dissimilar, left larger, somewhat acuminate, right very narrow. Female tract (Fig. 3) with elongate bursa with spermatheca at apex and appended gland at base of spermatheca. Latero-tergite IX with thick, membranous, plurisetose apex. Gonocoxite-1 with 10-12 lateral setae in apical third, gonocoxite-2 glabrous except for 2 minute setae in apical furrow. Pygidial gland (Fig. 4) reservoir relatively large with large dorsal lobe that is narrowly connected and clearly distinct from main reservoir, efferent duct medially expanded, collecting canal insertion near base of efferent duct.

KEY TO ADULTS OF *SPHODROSOMUS*

1. Anterior face of profemur with one medial and one basal seta; elytral dorsal surface scarcely papillose, relatively smooth in dorso-media third ..... *Sphodrosomus monteithi* sp. nov.
Anterior face of profemur with more than two setae, in most individuals arranged as a longitudinal row of 4-10 setae and cluster of 2-4 basal setae; elytral dorsal surface clearly and uniformly papillose throughout ..... *Sphodrosomus saisseti* Perroud & Montrouzier

Sphodrosomus monteithi sp. nov.
(Figs 1A-B, 2A-D, 3, 5)

ETYMOLOGY. Noun in the genitive case. This honours the collector Geoff Monteith, Queensland Museum, for his continuing contributions to entomology as an excellent collector and his generous assistance to entomologists.

MATERIAL. HOLOTYPE, ♂: New Caledonia, 20°34'S x 164°46'E, Mt Panié refuge, 1300m, 16-18Nov2000. Bouchard Burwell & Monteith. 9938 (MNHN). ALLOTYPE, ♀: New Caledonia, 9940, 20°34'S x 164°46'E, Mt Panié refuge, 1300m 16-18 Nov 2000. G.Monteith. Dung pitfalls, (QM T133291). PARATYPES, New Caledonia: 3♂, 2♀, Mt Panié, 1300m, 3 Nov 1988, R. Raven (1♂ BMNH, 1♂, 1♀ EMEC, 1♂, 1♀ QM); 9♂,

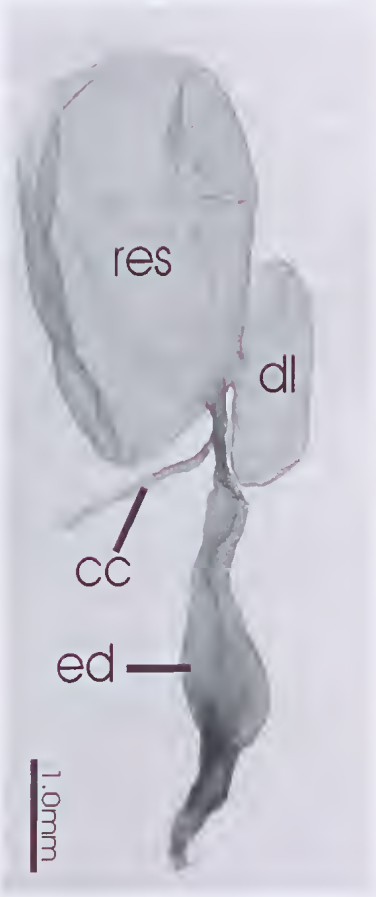


FIG. 4. Cuticular portion of a single pygidial gland of *Sphodrosomus sasseti*, right gland in left lateral view. res, reservoir. dl, dorsal lobe. cc, collecting canal. ed, efferent duct.

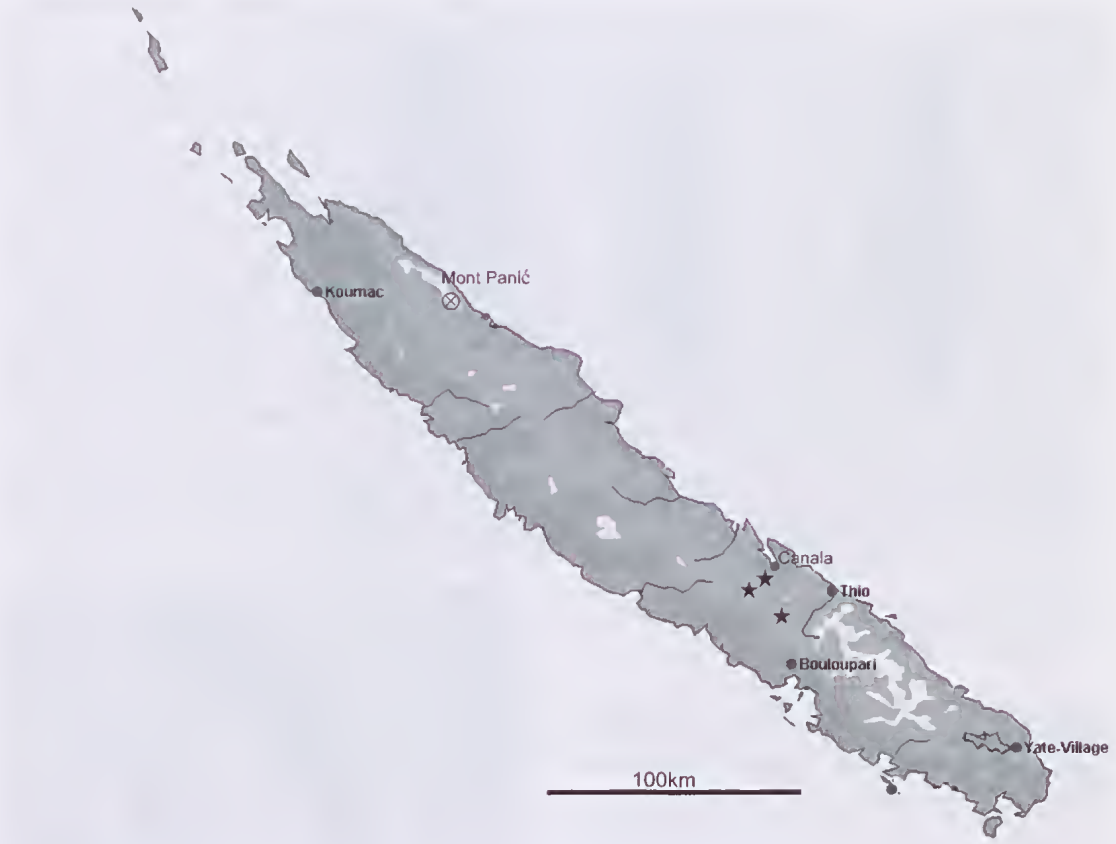


FIG. 5. Distribution of *Sphodrosomus* species. ⊗, *S. monteithi*. ★, *S. saisseti*.

8♀, Mt Panié, 1300m, 4-7 Dec 1990, R.J.Raven pitfalls, (9♂, 7♀ QM, 1♀ EMEC); 3♀, same data as allotype (QM); 1♂, 1♀, Mt Panié, 20°35'Sx164°45'E, 1300m, *Agathis montana* rainforest, R. J. Raven, 4-14 Dec 1990, pitfall traps (QM).

DESCRIPTION. Total length of holotype 24.5mm, greatest width 8.5mm. Colour black to rufopiceus, dorsally darker than ventral surface and legs. General body-form (Fig. 1A,B) elongate oval and acuminate to elytral apex. Suture between mentum and submentum notably sinuate. Glossal selerite with three setae on right side and one seta on left in holotype. Elytra with intervals 1-4 notably flatter than 5-8, interval 5 slightly elevated and 7 subearinate near base. Interval 9 with nearly continuous row of 30-33 small, umbilicate punctures, six to seven umbilicate punctures in interval 8 near apex. Elytral intervals slightly papillose to nearly smooth, smoother in basal third. Prominent isodiametrie mieroseulture in striae. Mesotroehanter without setae. Profemur with anterior 0-1 setae, dorsal 2-8 setae in irregular row, posterior 1 basal and 1 medio-ventral seta. Mesofemur with no anterior setae, dorsal 14-18 setae in irregular row, posterior medial row of 6-9 setae from base distally. Protibiae with two ventral rows of stout setae and apieal row of setae ended beyond single notably stouter and longer seta, two elip setae in antennal cleaner groove. Meso- and metatibiae with four longitudinal rows of setae eaeh, median row notably denser and with finer setae. All tarsi dorsally glabrous, with two rows of setae on ventral surfaee. Claws simple with single setae subtending eaeh elaw. Median lobe of aedeagus (Fig. 2A, B) with apex broadly rounded with slight bend in tip beyond ostium, tip short.

VARIATION. Range of lengths among type series 21-26.5mm, width 7.5-9.0mm. The number and distribution of setae on the glossal selerite varies as follows with *number of individuals*/ [left side][right side]: *14*/[2][2]; *6*/[1][2]; *2*/[3][2]; *2*/[1][1]; *2*/[2][3]; *1*/[1][3]; *1*/[2][1].

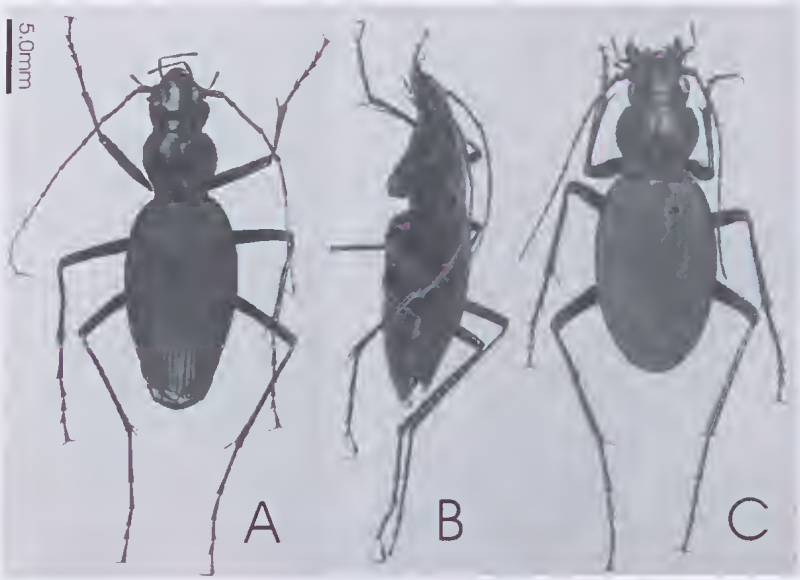


FIG. 1. Habitus images. A, dorsal and B, left lateral views of *Sphodrosomus monteithi* new species. C, dorsal view of *S. saisseti*.

elytra, the extremely long palps, long gracile legs, relatively large head (Fig.1) and a glossal sclerite that, in most individuals, has two pairs of apico-ventral setae rather than the more common condition of one pair. Specimens run to *Notonomus* in Moore's (1965) key to pterostichine genera of Australia and New Zealand but can be separated from members of that taxon by the lack of the dorsal setigerous puncture on the third elytral interval and, in most individuals, by the presence of two pairs of apico-ventral setae or at least two or more setae on one side of the midline of the glossal sclerite.

Additional descriptive notes for genus on aspects not covered by Perroud & Montrouzier (1864). Head with slight constriction behind eyes, two pairs of supra-orbital setae, clypeus with one pair of setae set medially from margin by 3 times width of setal pore, labrum with three pairs of setae, fronto-clypeal suture indistinct. Frontal foveae broad shallow, ending just anterad of anterior supra-orbital seta. Eyes not prominent, longest axis across eye twice width of sub-ocular gena. Suture between mentum and submentum distinct. Submentum with one pair of setae. Glossal sclerite in most specimens with two pairs of apico-ventral setae. Penultimate labial palpomere with one pair of setae. Maxillary stipes and palpifer with one seta each. Antennomeres 5-11 with thin, lateral, longitudinal carina. Pronotum with two pairs of lateral setae, base without marginal bead. Elytra with parascutellar striae and stria-1 continuous to base. Elytral interval 9, epipleura and narrow region across apex of elytra shiny and usually starkly contrasting with remaining, rather dull elytral surface. Elytra without basal and dorsal setiferous pores. Elytral plica present. Apical edge of elytra with deflexed edge. Protarsi of males and females not dilated and lacking squamose setae ventrally. Last abdominal ventrite with one pair

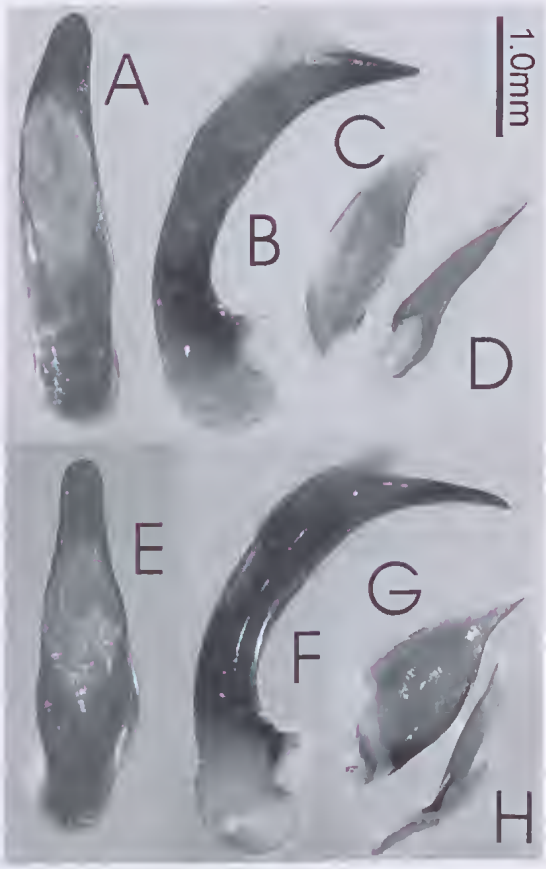


FIG. 2. Aedeagus of *Sphodrosomus monteithi* new species (A-D) and *S. saisseti* (E-H), median lobe in A, E dorsal and B, F left lateral views; C, G left paramere; D, H right paramere.

Sphodrosomus saisseti Peroud & Montrouzier (Figs 1C, 2E-H, 4)

DESCRIPTIVE NOTES IN ADDITION TO GENERIC DESCRIPTION. General body-form (Fig. 1C) elongate oval. Suture between mentum and submentum scarcely sinuate. Glossal sclerite with two pairs of setae on each side of midline (n=3). Elytra with intervals 3, 5 and 7 notably more convex and 7 subcarinate near base. Elytral intervals clearly papillose throughout. Profemur with longitudinal row of 4-10 setae and cluster of 2-4 basal setae. Median lobe of aedeagus (Fig. 2E, F) with apex broadly rounded with tip beyond ostium straight, long and thin.

LOCALITY RECORDS. (Fig. 5) The type locality for *Sphodrosomus saisseti* is Canala. New collection records for this species are 21°35'S 165°51'E, Mt Rembai, top junction, 800m, 19-30 Dec 2004, rainforest, G.Monteith, dung pitfall (1♀ QM); and 21°45'S 166°09'E, Ningua Reserve Camp, 1100m, 27 Nov 2001- 29 Jan 2002, rainforest, G.Monteith, pitfall (1♂ QM; 1♀ EMEC). Neukaledonien: Col Boa Foret de Niaouli 11.8.1965 Österr. neukaeldonien-Exped. (2♀ NMW: M. Baehr, pers. comm.)

DISTRIBUTION AND COLLECTING INFORMATION. Both species of *Sphodrosomus* have been collected in high precipitation, rainforest above 800m elevation. *Sphodrosomus monteithi* has not been collected below 1300m and specimens of *S. saisseti* that include elevational data range from 800m (Rembai) to 1100m (Ningua). The type locality of *S. saisseti*, "Kanala", most likely refers to Mt Canala (southwest of the town of Canala), which rises to 1050m. The new locality records for *S. saisseti* are within 30km of Canala, while the distribution of *S. monteithi* is separated by approximately 220km. Intensive collecting on most of the high mountain massifs on the island by members of the Queensland Museum in recent years, often using methods known to collect *Sphodrosomus*, suggest that the specimens so far collected are likely to represent the actual circumscribed distribution of the species. Based on limited observations of live *S. monteithi*, they have a fast moving gait and were found walking on wet nights, sometimes during heavy rain (G. Monteith, pers. comm.).

ACKNOWLEDGEMENTS

I thank Thierry Deuve (MNHN) for examining the syntypes of *S. saisseti* and providing character information, Martin Baehr (NHW) for sending specimen data and Geoff Monteith (QM) for specimens, information on the new species and advice on the manuscript for this contribution.

LITERATURE CITED

CSIKI, E. 1929. Carabidae: Harpalinae III (Pars 104). Pp. 347-527. In Junk, W.S. & Schenkling, S. (eds) Coleopterorum Catalogus. (Junk: Berlin).

1930. Carabidae: Harpalinae IV (Pars 112). Pp. 529-737. In Junk, W.S., Schenkling, S. (eds) Coleopterorum Catalogus. (Junk: Berlin).

FAUVEL, A. 1882. Les Coléoptères de la Nouvelle-Calédonie et dépendances avec descriptions, notes et synonymies nouvelles. Revue d'Entomologie 1: 265-274.

ICZN. 1999. International Code of Zoological Nomenclature. International Trust for Zoological Nomenclature. (The Natural History Museum: London).

LORENZ, W. 2005a. A systematic list of extant ground beetles of the world (Coleoptera "Geadephaga": Trachypachidae and Carabidae, incl. Paussinae, Cicindelinae, Rhysodinae). (Published by author: Tutzing).

2005b. A directory of the scientific names of ground beetles (Coleoptera "Geadephaga": Trachypachidae and Carabidae, incl. Paussinae, Cicindelinae, Rhysodinae). (Published by author: Tutzing).

MOORE, B.P. 1965. Studies on Australian Carabidae (Coleoptera) 4. The Pterostichinae. Transactions of the Royal Entomological Society of London 117: 1-32.

PERROUD, B.P. & MONTROUZIER. 1864. Essai sur la faune entomologique de Kanala (Novelle-Caledonie) et description de quelque espèces novelles ou peu connues. Annales de la Société Linnéenne de Lyon (NS) 11 (11): 46-257.

TSCHITSCHÉRINE, T. 1901. Note sur les Platysmatini de l'Australie. Horae Societatis Entomologicae Rossicae 35 (1902): 502-534.

WILL, K.W. 2002. Revision of the new world abariform genera *Neotalus* n. gen. and *Abaris* Dejean (Coleoptera: Carabidae: Pterostichini (Auctorum). Annals of the Carnegie Museum of Natural History 71: 143-213.

JRNL
C43-45

CONTENTS

BAEHR, M.
A peculiar new genus of Arboricolous Lebiinae from inland Australia (Insecta: Coleoptera: Carabidae: Lebiinae) 1

CASSIS, G. & MONTEITH, G.B.
A new genus and species of Cylapinae from New Caledonia with re-analysis of the *Vannius* complex phylogeny (Heteroptera: Miridae) 13

CATERINO, M.S.
Chlamydopsinae (Coleoptera: Histeridae) from New Caledonia 27

DENNIS, A.J. & CUNNINGHAM, M.J.
Litoria Richardsi sp. nov., a new treefrog (Anura: Hylidae) from New Guinea 65

HAMANN, M., SCHÄUBLE, C., SIMON, T., JOHNSON, J., EVANS, S., DORR, T. & KENNETT, R.
Sea turtles nesting in the Sir Edward Pellew Islands, Gulf of Carpentaria, Northern Territory 71

HLAVÁČ, P., MONTEITH, G.B. & DUNAY, G.
Pselaphinae (Coleoptera: Staphylinidae) of New Caledonia and Loyalty Islands. I. *Taomica*, new genus of Pselaphini and a catalogue of Pselaphinae 79

KOHOUT, R.J.
Review of *Polyrhachis (Cyrtomyrma)* Forel (Hymenoptera: Formicidae: Formicinae) of Australia, Borneo, New Guinea and the Solomon Islands with descriptions of new species 87

KROON, F.J. & JOHNSON, J.W.
Range extension for the Mulgrave River Goby (*Glossogobius* sp.) (Pisces: Gobiidae) in North Queensland 147

LI, X. & DAVIE, P.J.F.
An account of the Pandaloid shrimps (Crustacea: Decapoda: Caridea) in the collections of the Queensland Museum 151

MOULDS, T. & CASSIS, G.
Review of Australian species of *Peritropis* (Insecta: Heteroptera: Miridae: Cylapinae) 171

GABRIELA MUÑOZ, G. & CRIBB, T.H.
Parasite communities and diet of *Coris batuensis* (Pisces: Labridae) from Lizard Island, Great Barrier Reef 191

SEWELL, K.B., CANNON, L.R.G. & BLAIR, D.
A review of *Temnohaswellia* and *Temnosewellia* (Platyhelminthes: Temnocephalida: Temnocephalidae), ectosymbionts from Australian crayfish *Euastacus* (Parastacidae) 199

WILL, K.W.
A new species of the New Caledonian genus *Sphodrosomus* Perroud (Coleoptera: Carabidae: Pterostichini) 281

IN MEMORIAM
Dr Peter William Arnold 7